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Journal

—OF THE—

American Ceramic Society

A Monthly Journal devoted to the Arts and Sciences Related to the Silicate Industries.

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EDITORIALS.

SOME ASPECTS OF SCIENTIFIC RESEARCH IN RELATION TO THE GLASS INDUSTRY.[1]

By Edward W. Washburn,
Professor of Ceramic Chemistry, University of Illinois.

Although one of the most ancient of the chemical industries, the manufacture of glass, like most of the other ceramic industries, has been one of the last to feel the influence of modern science. This is, of course, due largely to the fact that the industry, being older than the science, had necessarily to develop along purely empirical lines. The rule of thumb methods, and their accompanying "trade secrets," which characterize the development of a complex industry by this method naturally bred a conservatism of view-point which did not easily appreciate the value of scientific research or the advantages of scientific control over the materials and the processes of the industry. Furthermore, it must be admitted that until comparatively recent times the chemistry and physics of high temperatures, such as those prevailing in the most important processes of this industry, were so little developed that the science was scarcely itself in a position to render important service to the industry, such a service for example, as organic chemistry has rendered to the synthetic dye industry which is a typical example of a great industry built upon a highly

[1] Address before the American Ceramic Society meeting held at the Fifth National Exposition of Chemical Industries, Chicago, Ill., September 24, 1919.

developed scientific foundation and completely under the control of scientific methods and the results of continuous research.

During the last quarter of a century, however, there has been a gradual change in this situation with respect to the glass industry. With the development of methods of producing, controlling and measuring high temperatures in the laboratory our knowledge of the chemistry and physics of high-temperature processes has gradually and steadily increased. With the expansion of our knowledge in this field have naturally come opportunities to apply its methods, laws and data to the solution of industrial problems. The more enterprising glass manufacturers began to employ chemists in their plants and in laboratories which they installed. Starting initially as a works laboratory, sometimes illy equipped and miserably housed, they busied themselves at first almost entirely with control problems and works' troubles. After they began to demonstrate their usefulness, their opportunities, responsibilities and resources both in men and equipment naturally increased and the beginnings of real research laboratories in connection with the glass industry appeared.

Then came the great war and America awoke to the realization that she must rely solely upon her own resources for the manufacture of all the different kinds of glass which she required. One of the first results of this situation was the quantity production of a grade of chemical glassware, the equal and in some respects the superior of that for which we had previously been dependent upon Germany. This new American glass is essentially a product of scientific research and was developed by men trained in the principles of modern chemistry and physics and having the necessary laboratory facilities at their disposal.

Then came America's entrance into the war and with it the realization that we should need hundreds of tons and numerous varieties of optical glass, that is, glass conforming to the most rigid specifications, as to color, transparency, homogeneity, and freedom from striations, bubbles, stones or other imperfections which might interfere with vision; and on top of these qualifications each of the various types required had to have a definite and rigorously fixed index of refraction and coefficient of constringence. The extent to which the glass in an officer's binoculars,

or the glass in a gunner's range-finder, or the glass in a submarine or trench periscope, met or failed to meet these rigid specifications would probably be measured in terms of human lives. The situation which existed in this country with respect to optical glass, at the time America entered the war, was thus a real crisis. It is not my purpose to tell you the story of how this crisis was met. This will be ably done by others on today's program who are competent to speak from first-hand knowledge of the problems met and solved. Suffice to say that the crisis *was* met and the problems which *had to be solved were solved* and their solution brought about a degree of coöperation between the practical man of the factory and the scientist of the laboratory which would probably have required many years to bring about without the stimulus of war. With this coöperation there naturally developed a mutual respect, understanding and appreciation on both sides which should mean much for the future of the glass industry in this country.

If today we put to the glass industry of America the question, "Do you know how to carry out the multifold operations necessary in order to produce good chemical-glassware, good optical glass, good plate glass, good X-ray bulbs, good incandescent bulbs, etc.?" the industry can truthfully answer, "Yes." Also, if we put the question, "Do you know how to do it efficiently?" the industry can still in many respects truthfully answer, "Yes," although in some cases, perhaps, in a rather weak voice. But if we put the question, "Do you know why you do thus and so, and do you know what happens at this or that stage of the process?" the industry must in the majority of cases reply, "We do not know."

Now, it is not enough to know *how*, we must also know *why*. For quality of product, it is perhaps sufficient merely to know how, but for efficiency, safety and confidence as well as for progress it is also necessary to know why. No industry which merely knows *how* is in a healthy condition. The feeling of confidence which comes with knowing the why of every step in the manufacturing process carries with it certainty of control, progressive lowering of costs, enhanced protection of the workmen, progress in the development of new and improved products, and a degree of insurance against such evils as might otherwise

attend the exhaustion or temporary scarcity of certain raw materials, fuels, machinery or other necessary supplies.

In the face of the imperative demands of war, or of the almost unlimited markets created by the destruction wrought by war, the necessity of operating with the greatest efficiency is not felt by an industry as it is in normal times with close competition and a market whose further expansion is dependent primarily upon lower selling prices. This is well illustrated in the case of the first two glass factories to resume production after the evacuation of Belgium by the Germans. These two factories, which I had the opportunity to visit last summer, are located in the same district and, therefore, subject to the same conditions regarding fuel, common labor and costs of materials. They are both engaged in the manufacture of window glass, for which, for some time to come, there will be an enormous demand for reconstruction in the devastated regions. In the first factory the glass is manufactured by the older process in which the "metal" is gathered directly from the furnace on the end of the blower's pipe and then blown into a long cylinder which is cut lengthwise, transferred to the flattening furnace and there flattened into a sheet by a second workman. In this factory the blowers are paid from $250.00 to $300.00 per month. In the second factory, operating under the Fourcault patents, the process is entirely mechanical, no labor, other than that employed in firing, being employed between the point at which the "batch" is shoveled into the tank furnace and the point at which the completed panes of glass issue from the furnace. The highest-paid workman in this plant received about 18 cents per hour. In spite of the apparently great difference in efficiency and in costs of the two methods of operation they were nevertheless both able to operate at a profit in a market where demand and not manufacturing costs is the principal element in determining the price of the product.

In the laboratories associated with an industry the work to be done may perhaps be roughly classified under three headings: First, *routine testing* of raw materials and products and similar work having to do with the control of the operation of the factory. Second, *works problems*, that is the solution of problems whose immediate purpose is the cure of some source of trouble in the

works or the improvement of some part of the process or product. Third, *fundamental research*, that is, research whose primary purpose is to find out the why of some stage of the operation, or to secure quantitative scientific data concerning the materials used, the processes occurring and the product obtained both in its completed state and in different stages of its manufacture.

It is the importance of the last type of work which I wish to emphasize particularly for it is only by the solution of these more general and fundamental problems that the scientific foundation of an industry can be laid. In the glass industry almost everything still remains to be done in this respect. For example, we know that the relation between the viscosity of the "metal" on the one hand and its temperature and composition on the other is one of the important elements which is associated with the operations, of stirring. gathering, drawing and blowing and yet one searches the literature in vain for any measurements of the viscosity of industrial glasses. The Germans may have secured these data, but if so, they have not published them. During the last two years we have been working on this problem at Illinois and have succeeded in perfecting an apparatus and in determining the viscosity-temperature curves for seven of the more important types of optical glasses.

Similarly, we know in a general way the mathematical theory of the process of fining and know that it is closely connected with the viscosity, with the surface tension and with the vapor pressure of the molten glass, but no measurements of surface tension of industrial glass seem ever to have been made, neither are any data concerning the vapor pressures of glasses at different temperatures or concerning the composition of the vapor available. Not even such a simple property as density seems ever to have been determined in the case of molten industrial glasses. Our knowledge of the reactions which take place in the melt, of the compounds which form, particularly those which crystallize out, and of the conditions under which they crystallize out, is still very fragmentary. Again, we know that soda can be substituted for potash to a large extent in certain optical glasses without impairing the index of refraction, but it is stated that this substitution is impracticable, because of the increased color which ac-

companies it. We do not know, however, the cause of this increased color, or whether it even is actually and primarily a necessary accompaniment of the use of soda.

There are numerous other examples of troubles for which the cure has been found, but concerning which we know nothing whatever of the true nature of the disease, or why the remedy employed resulted in a cure. It would not be at all surprising to find in some of these instances that the cure was not directly produced by the remedy employed, but resulted from some unrealized variable whose alteration accidentally accompanied the application of the remedy, the supposed remedy itself having nothing at all to do with the matter.

We know scarcely anything concerning the nature of the gases which remain in solution in the glass even after its completion nor do we know what rôle, if any, they play in determining the properties of the glass. It is quite reasonable, for example, to suppose that a method of manufacture which controlled the nature and quantity of these dissolved gases might produce an incandescent lamp bulb having a much longer life than those at present employed, and might place in the hands of the physicist a type of apparatus glass which would be of great value in high-vacuum investigations. The present methods of manufacture, as you know, exert no control whatever over this component of the glass.

The relation between some of the optical properties and the compositions of glasses has been extensively studied, but in the case of many of the other physical properties our knowledge is almost zero or at best only fragmentary. Suppose we desire, for example, to manufacture the most suitable glass for sealing in the lead wires of an incandescent light bulb, what do we know about the laws which govern the relation between the electrical conductivity of a glass and its composition? Almost nothing. I have seen a large Mazda lamp bulb destroyed in less than an hour's use owing to the electrolysis which occurred between the two leading-in wires, resulting in the formation of a layer of bubbles along one wire and a consequent destruction of the vacuum.

The purely scientific questions which present themselves for solution are almost infinite in number:

1. Under what conditions does one get metallic copper and cuprous oxide in a glass and how can one distinguish between them?

2. In a chrome-aventurine glass is the second phase chromic oxide or a chromic silicate?

3. Why does fluoride give a white glass with no red by transmitted light?

4. What compound gives the pink color with manganese?

5. What gives the red color in chrome pink?

These are a few questions which have been recently brought to my attention by an authority on colloid chemistry.

Some of the lengthy discussions which one finds in the literature concerning some of the questions arising in connection with glass manufacture are after all rather futile ones. The famous case of arsenic is an example. Much printer's ink has been employed in discussions as to what happened to the arsenic after it was put into the batch, just what influence it had on the properties of the glass and why it had this influence. Did it remain in the glass as As_2O_3 or was it oxidized as As_2O_5? In the discussion of this latter point, for example, by two such authorities as Dr. Hovestadt and Dr. Rosenhain, we find one of them claiming that if an oxidizing material is employed in the batch the arsenic remains in the glass as an arsenate, while if no oxidizing agent is employed no oxidation of the arsenic can occur and it is all driven out in the vapor. The other believed that since arsenic acid is easily reduced by heat alone any arsenic remaining in the glass was present as As_2O_3, and since arsenic acid was a weak acid it could hardly remain in combination with the alkalies and, therefore, its presence in the glass would result in the formation of insoluble impurities and a consequent opalescence. Now all of this discussion concerning the rôle of arsenic and its amount or condition in the finished glass has been a needless one, in so far as the questions raised were worthy of solution, because the problem under discussion was one which the resources of chemistry have long been in a position to definitely solve, if any one had taken the trouble to carry out the necessary experiments as has in fact been recently done.

There is thus no lack of chemical and physical problems in

connection with the glass industry whose solution requires only the painstaking work of trained investigators. It is not enough, however, to merely point out the great need of fundamental research in this field; it is necessary that definite steps be taken to prosecute this research as vigorously as possible. Now there are three types of laboratories in which research of this nature might be carried out. First, the research laboratories of the industry itself. These laboratories while as yet few in number may be expected to grow both in number, equipment and personnel and a portion of their resources should be devoted to some of the more fundamental problems common to the industry as a whole, as a part of their contribution to the general advancement of those branches of the physics and chemistry underlying the industry. Second, the government laboratories and the laboratories of research foundations, such as the Geophysical Laboratory. These may be expected to continue their work along these lines and should receive the support of the industry in their efforts to extend their facilities for such work. Third, the laboratories of the ceramic departments of the universities. Now, although we have some half-dozen departments of ceramics in the country at the present time, these departments have grown up around and been fostered by the clay industries and have as a natural result confined most of their activities in the past to these branches of ceramics. There exists nowhere in the United States a single professorship of glass technology. The endowment of such professorships by the industry would do much toward stimulating research in this field in our universities and in attracting young men to the study of this subject. And when all is said, it is, after all, the scarcity of trained men which is at the present time the greatest impediment to the more vigorous prosecution of research in this field. The Board of Advisors of the Department of Ceramic Engineering at the University of Illinois appreciated this situation and at its meeting in 1915 voted to recommend to the trustees that such a professorship be established by the University. Before any action could be taken, however, the disruption consequent upon our entrance into the war made it necessary to postpone the consideration of any expansion in the work of the Department and at the present

time the financial situation at the University is such that any expansion in its activities is out of the question. The universities of the country with but few exceptions have been unable to make any general increase in the salaries of their teaching staffs to meet the increased cost of living during the past four or five years and until they are in a position to correct the present desperate condition in which they find themselves, owing to the continued resignation of teachers of technical subjects, any plans looking towards expansion of activities by the creation of additional professorships could scarcely be justified.

I believe that no one of the institutions at which a department of ceramics exists is financially able at the present time to expand its activities. In fact, most of them have had to contract their activities and to struggle along with a reduced staff and smaller resources than they had before the war. If the glass industry is desirous of securing the coöperation of university laboratories in training additional men for the industry, and in helping to solve some of the fundamental problems in this field, some way of providing the needed financial assistance must be found.

The industry cannot afford to have the source of supply of its future technical staffs dry up and that is just what is occurring. A steady stream of requests for technically trained men for the glass industry and the other ceramic industries comes to my desk throughout the year. More and more of these requests are for men with graduate training, that is, men trained to do research. These men are not being produced. Few, if any, of our Ceramic departments are at the present time in a position to properly train such men for the glass industry. Such training is the most expensive which a university gives. Adequate fellowship funds are needed to enable the men to complete the course of training required to produce a research worker. Where six years ago a fellowship of four or five hundred dollars would pay a student's living expenses, today double that amount is required.

In the past the industrial world was content to rely entirely upon the universities for the advancement of science, but today there are many signs that scientific leadership is passing from the hands of the university to the hands of the great industrial research laboratories and the privately endowed research founda-

tions. Scientific research is becoming more and more costly and the universities as organized at present can no longer compete on terms of equality with the efficiently organized and adequately financed industrial and endowed research laboratories.

Thus, although no longer entirely dependent upon the universities for scientific research, the industrial world is and must continue to be entirely dependent upon them for the training of its technical personnel, and a part of the responsibility for seeing that such training is provided must in the future be accepted by the industries. Although the Sherman law forbids the formation of combinations in restraint of trade, there is, I believe, nothing in that Act which forbids the formation of combinations within an industry for the purpose of uniting on a program for furthering research on fundamental problems and for aiding the universities of the country in the work of training the technical personnel required by the industry.

SUPERIOR REFRACTORIES.[1]

By Ross C. Purdy.

This is a plea to the American Ceramic Society to initiate directly, or through the agency of the National Research Council, active and thorough researches of our refractory problems by a Federal bureau. This recommendation is made in spite of a keen appreciation of the excellent work which has already been completed and at present being undertaken by the Federal Bureaus, the National Research Council, the American Ceramic Society, the Refractories Association, the American Society for Testing Materials and other organizations. Much has been done by our universities and much by industrial concerns. In the presentation of this plea there is no forgetting of the advances we have made through the efforts of these several agencies and there is no thought but that these several bureaus, societies, universities and industrial concerns should continue independent researches

[1] Address before the American Ceramic Society meeting held at the Fifth National Exposition of Chemical Industries, Chicago, Ill., September 24, 1919.

on refractories as has been their wont, and as they no doubt are continuing, for there are advantages in independent investigations by several organizations each with its peculiar purposes, viewpoints, facilities, etc. Indeed, we want more of this dispersion of interest and activity in researches on refractories. It would be well if each of the several bureaus, societies, colleges, etc., would see the great need there is for progressive and aggressive investigations of our refractory problems and each independently initiate and prosecute researches in this the one branch of Ceramics in which we are the most backward in meeting the industrial demands for a better product.

Notwithstanding this keen appreciation of the benefits derived from independent investigations and researches by several, we must recognize the advantages of unrestricted facilities, not alone in expensive and varied equipment to meet every desired requirement, but also in facilities for very accurate observations and to the obtaining of trustworthy constants such as can be obtained only with highly trained investigators and expensive apparatus. We must appreciate also facilities for broad observations, not alone in the development and manufacture of refractories, but also as to the industrial needs for refractories. It is very obvious that the most rapid and the most certain progress in the development of refractories can be had only by an elaborate and aggressive investigation, an investigation that is beyond the possibilities if not beyond the scope of independent organizations of small financial resources and limited interest.

Then, too, the benefits would not be alone to the manufacturers of refractories, indeed not as much to them as to the users, and to the national and world-wide welfare. It does not require much breadth of thought to realize how dependent is our present-day industrial progress on the development and manufacture of superior refractories, refractories that are superior for the several purposes to those now being used. Consider for a moment the saving of time and of labor and of metal that is effected by the closed electric furnace over the open-top crucible for brass melting. Electric furnaces today are melting less than one per cent of the brass used and yet they are saving a million dollars' worth of zinc metal by reducing its loss from 6 to 9 per cent down to

one per cent and less. In this one operation alone they are not only saving metal but also labor, and at the same time are making the operation more tolerable for the operators. Examples could be multiplied by reference to the many heat-treating operations where with development of new equipment and processes they are effecting economies and bettering operating conditions. But these benefits cannot be fully realized until more suitable refractories are developed. The rapid development and adoption of electric furnaces for a large number of purposes has given rise to an urgent appeal for better refractories. The development and rate of adoption of the electric furnace has been phenomenal but is greatly retarded by want of suitable refractories.

There is an urgent need today for an understanding of the qualities or properties that are wanted in each of the large number of industrial requirements. This is no small task. It involves accurate observations and study of possible variations in operation control in the place and under the conditions that refractories are used. It requires a knowledge of metallurgy and of ceramics and above all it requires an appreciation of the relation of costs to service. The most suitable refractory will at the best be a compromise, not alone because of the antagonistic properties that are required, but also because of the economics of service involved. An adequate and worth-while industrial survey and research of refractory requirements is so far beyond the possibility and scope of individual organizations, and the benefits derived are so broad, affecting the cost and pleasure of living of every citizen, that it should be made under the auspices of a Federal Bureau where the expense is borne by general taxation.

If a discussion of the political economics involved were needed, it could be shown that since our national welfare is more and more dependent on industries as compared to agriculture, and since the farm and the industries are today more mutually dependent than at any previous time, all citizens should share in meeting these costs. And if the economic considerations were carried farther, it would be plain that efficiency, relating to time and money expended as balanced against the value of results obtained, would require the employment of the broadest-trained investigators, the most accurate and efficient equipment, and the most liberal

opportunities, all of which are possible only under Federal auspices.

Then, too, there should be extensive research of material resources and manufacturing processes. This should parallel the industrial survey. The two should be closely associated and each be given liberal support. A Federal bureau would secure for this a far better coöperation of the independent organizations than could any other agency, a coöperation that is very essential.

A great deal of progress has been made in the last two decades, not alone in refractories themselves, but also in our appreciation of the relative value of the chemical and physical means of judging their suitability. We no longer hear of the mistaken and much over-emphasized importance of chemical analyses of clays. We have not, and probably never will, discard the chemical analysis as being without value. It has a value, for it does give information, but we certainly have less faith today in the empirical methods of Bischof, Seger and Ludwig for estimating the refractoriness of clay from the chemical analysis. We have learned, too, that clays having the same chemical analysis but differing in physical and mineral character may have different values for refractory purposes. Indeed, it is not uncommon that a freshly mined clay would have but small value for use in refractories but will be made an excellent clay by merely weathering. This is an instance of the importance of texture and structural strength, factors that are not disclosed by chemical analysis.

We are appreciating more and more that the success of a clay for refractories is as largely dependent upon the physical properties that make it adaptable for manufacturing processes, as it is on its chemical and mineral composition. Indeed, the fact is slowly being appreciated that behavior of a clay in the usual fusion test is dependent on physical properties as well as on its chemical composition. No method yet devised can be substituted for the direct fusion test.

Decided progress has certainly been made in knowledge of the method of study, and progress has also been made in knowledge of what is essential in refractories, but we have made but little in the actual production for specific purposes.

It is not the purpose here to elaborate upon the relative values of the several methods of studying refractory materials and wares

or how to produce desired properties in the finished ware. We are making fair progress in these.

What we need today is the development of refractories that will remain practically constant in their physical and chemical characteristics through the maximum heat treatment to which they will be subjected when in use. We recognize that when a clay is burned in a fire-brick kiln the melting together of its mineral constituents is but partly progressed and that further reactions and solution will take place when the clay is subjected to more severe heat treatment. We also recognize the importance of such factors as time, oxidation, etc., in the progress of clay fusion. It is well known that clays that appear equal in the fusion test will differ in load-carrying capacities when subjected to heat treatments much less severe than those required to cause them to deform in the fusion test, and we recognize this as one indication that suitability of a clay refractory is not wholly dependent upon its ultimate fusibility, but in fact is more dependent upon its rate of fusion.

From the evidence that is already before us it is apparent that, for the most severe heat requirements, the refractory must have had its physical and chemical properties developed to their maximum; far beyond the possibility of alteration in any heat treatment to which they will be subjected in use.

If fused bauxite, fused alumina, sintered magnesia, or silicon carbide would meet all the industrial high-temperature requirements, there would be no need for this plea for Federal research on refractories. There are needs which these materials will not satisfy and for which materials, such as the spinels, sillimanite, zirconia, etc., are better suited. We have heard much of the possibilities of zirconia as a refractory and have had several industrial trials of refractories made of zirconia, but we know little aside from the fact that we cannot yet produce a zirconia refractory that is economically possible. The same is true of sillimanite, a most excellent refractory of exceptionally low electrical conductivity.

The value of these fused refractory-oxides lies, not alone in their extreme refractoriness, but also in their constancy in volume, capacity to withstand sudden temperature change, resistance to chemical and slag reactions and ease with which a desired texture

can be produced. Refractory articles from these materials average much higher in desired or required properties than any of the partially fused or partially sintered refractories. No refractory will carry load at high temperatures and withstand the destructive abrasive, slagging and temperature changes as will fused bauxite, silicon carbide or sintered magnesia. These same superior values might be found with other materials which have been previously fused.

The great problem with these materials, however, is their production at a cost compatible with the service they will give. The solution of this problem is not easy and certainly deserves the serious attention of a Federal bureau with extensive capacity to conduct investigations in the laboratory and field.

The plea that is being presented is that the American Ceramic Society initiate and secure coöperation by the several other Societies in a request for aggressive researches by some Federal Bureau in the development and economic promotion of refractories. This will include a definition of the possibilities of clay refractories; an improvement in such as the silica and magnesite refractories; but such a research should especially develop and define the most economic methods of production and use of such superior refractories as can be made of zirconia, the spinels, sillimanite, the nitrides, etc. This is no small program. It will tax even a Federal Bureau, if executed with the vigor that the present urgent industrial demands fully warrant.

This plea is respectfully submitted to the Standing Committee on Research for their careful consideration.

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WORCESTER, MASS.

or how to produce desired properties in the finished ware. We are making fair progress in these.

What we need today is the development of refractories that will remain practically constant in their physical and chemical characteristics through the maximum heat treatment to which they will be subjected when in use. We recognize that when a clay is burned in a fire-brick kiln the melting together of its mineral constituents is but partly progressed and that further reactions and solution will take place when the clay is subjected to more severe heat treatment. We also recognize the importance of such factors as time, oxidation, etc., in the progress of clay fusion. It is well known that clays that appear equal in the fusion test will differ in load-carrying capacities when subjected to heat treatments much less severe than those required to cause them to deform in the fusion test, and we recognize this as one indication that suitability of a clay refractory is not wholly dependent upon its ultimate fusibility, but in fact is more dependent upon its rate of fusion.

From the evidence that is already before us it is apparent that, for the most severe heat requirements, the refractory must have had its physical and chemical properties developed to their maximum; far beyond the possibility of alteration in any heat treatment to which they will be subjected in use.

If fused bauxite, fused alumina, sintered magnesia, or silicon carbide would meet all the industrial high-temperature requirements, there would be no need for this plea for Federal research on refractories. There are needs which these materials will not satisfy and for which materials, such as the spinels, sillimanite, zirconia, etc., are better suited. We have heard much of the possibilities of zirconia as a refractory and have had several industrial trials of refractories made of zirconia, but we know little aside from the fact that we cannot yet produce a zirconia refractory that is economically possible. The same is true of sillimanite, a most excellent refractory of exceptionally low electrical conductivity.

The value of these fused refractory-oxides lies, not alone in their extreme refractoriness, but also in their constancy in volume, capacity to withstand sudden temperature change, resistance to chemical and slag reactions and ease with which a desired texture

can be produced. Refractory articles from these materials average much higher in desired or required properties than any of the partially fused or partially sintered refractories. No refractory will carry load at high temperatures and withstand the destructive abrasive, slagging and temperature changes as will fused bauxite, silicon carbide or sintered magnesia. These same superior values might be found with other materials which have been previously fused.

The great problem with these materials, however, is their production at a cost compatible with the service they will give. The solution of this problem is not easy and certainly deserves the serious attention of a Federal bureau with extensive capacity to conduct investigations in the laboratory and field.

The plea that is being presented is that the American Ceramic Society initiate and secure coöperation by the several other Societies in a request for aggressive researches by some Federal Bureau in the development and economic promotion of refractories. This will include a definition of the possibilities of clay refractories; an improvement in such as the silica and magnesite refractories; but such a research should especially develop and define the most economic methods of production and use of such superior refractories as can be made of zirconia, the spinels, sillimanite, the nitrides, etc. This is no small program. It will tax even a Federal Bureau, if executed with the vigor that the present urgent industrial demands fully warrant.

This plea is respectfully submitted to the Standing Committee on Research for their careful consideration.

NORTON CO.,
WORCESTER, MASS.

ORIGINAL PAPERS AND DISCUSSIONS.

THE GEOLOGY OF THE CATSKILL PORTLAND-CEMENT REGION.

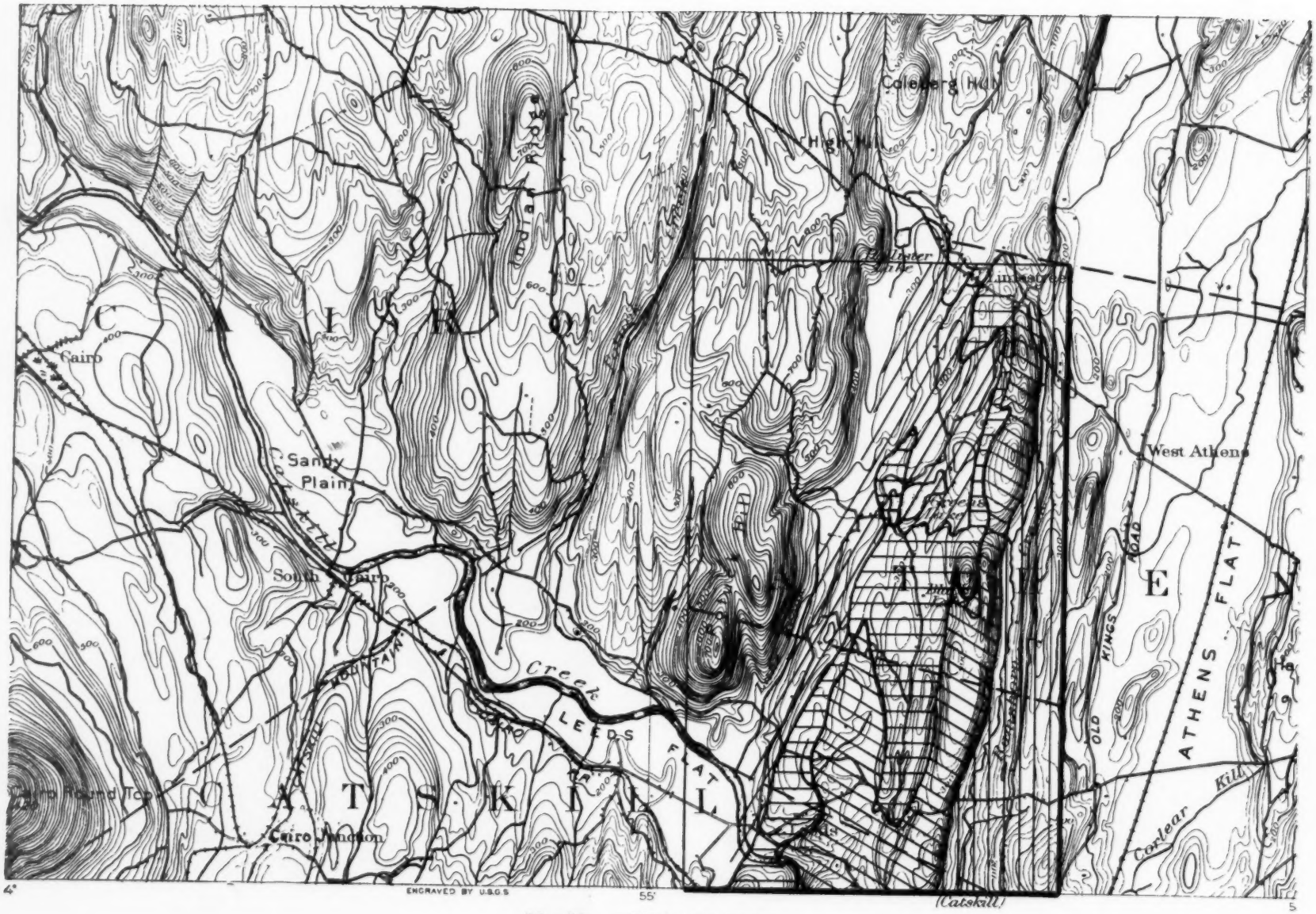
By Robert W. Jones.

The production of portland cement, in the Hudson valley, was placed on a commercial basis about 1900. Several attempts at commercial production had been made as early as 1875 but the results were not exactly encouraging and until the Becraft mountain section began to produce the output was not very large. The opening of the Becraft mountain section was soon followed by active production in the adjacent Catskill region.

The geology of the Becraft mountain regions has been very thoroughly studied.[1] Becraft mountain is a noted outlier of Siluric and Devonic formations. The economic value of these formations has been very seldom taken into account by the geologists who have investigated the region.

West of the Hudson river, in the Catskill region, the identical formation, as exposed at Becraft mountain, excites no interest among geologists in general. The geology of this region is supposed to be simple. The great economic features of this region and its formations have not been realized. It is due to a general lack of information, among certain industries, that we are stating in as brief a manner as possible, the general geologic conditions of a portion of this limestone belt. Our statements can only be used as a basis upon which the detailed geology of any particular section may be enlarged.

[1] Amadeus W. Grabau, "Stratiagraphy of Becraft Mountain, Columbia County, N. Y." N. Y. State Museum, *Bull.* **69**, 1030–1079 (1902).



Map No. 1—Black Lake Region.

In describing the geology of the Catskill region, from the viewpoint of the cement technologist, we have taken the liberty of dividing the regions in two divisions, which, for purpose of reference, we have designated Black Lake and Van Luven Lake, taking the names from two locally well-known bodies of water. These two sections, almost directly north and south of each other, are separated by a distance of approximately two miles. The intervening section is economically of no importance as regards this discussion. It is occupied by the valley of the Catskill creek, where it breaks through the limestone area. Of the two divisions the Van Luven Lake is the only producer having three plants, known locally as the Acme, Alsen and Alpha. The Van Luven Lake area is commercially and practically distinct from the Black Lake area. The supply of limestone in the Van Luven Lake area, under the present methods of mining, is limited. The supply of limestone in the Becraft region is decidedly limited. The Black Lake region, as shown in the accompanying map (No. 1), is the southern extremity of a very great body of limestone.

The region west of the Hudson river consists of roughly parallel valleys following fairly close to the general direction of the river. In the area under discussion, a maximum of eight hundred feet elevation is reached. It is roughly divided into three natural physical divisions; the lower, level clay flats having a maximum of two hundred feet elevation and with comparatively few rock outcrops; the limestone region with a rather abrupt eastern boundary, an abundance of rock outcrops, a rather shallow soil deposit, and many north and south flowing swampy streams; the higher range of semi-isolated sandstone and shale elevations with a very abrupt eastern face and a low rolling western exposure. The cement-products region lies in the first two divisions. The general geologic structure of the region consists of an eastern sharply folded limestone and sandstone belt gradually dipping under the almost level Devonic shales and sandstones to the west. To the east of the limestone belt is an area of very sharply folded shales and sandstones of Ordovicic age.

Clay is used as the source of silica at all of the plants. It is secured from the immediate neighborhood of the mills. The clay deposits are fairly uniform in composition and are abundantly

able to take care of any production of portland cement for many years. The limestones are somewhat restricted by variation in chemical composition.

In order to properly understand the geologic and economic conditions of this region, we refer to the following tabular arrangement of the various formations exposed. Under the unit division we have purposely left out the rock designation, as certain of the formations vary from the exposures at their typical locality.

System.	Group.	Unit.
Devonic	Erian	Hamilton Marcellus
	Ulsterian	Onondaga Schoharie
	Oriskanian	Esopus Oriskany Port Ewen
	Helderbergian	Becraft New Scotland Coeymans
Siluric	Cayugan	Manlius Rondout Cobleskill
Ordovicic	Canadian	Normanskill

The **Hamilton** brown, gray and black sandstones and shales occupy the western and northwestern portions of both the Black Lake and Van Luven Lake areas. They are economically of little importance. They are the highest in the geological scale of the formations represented in the two sections. The contact between the Marcellus shale and the Onondaga limestone is seldom exposed.

The **Onondaga** limestone is decidedly distinct from the other limestones of the Hudson valley as far as physical characteristics are concerned. It is massive, heavy bedded and with an abundance of typical fossils. It is slightly lower in lime and considerably higher in silica and alumina than the other limestones of this

region. Owing to its comparative great resistance to the weather it is prominently exposed along the outcrop. It breaks well along the bedding and along two sets of joint planes at right angles with each other. It has not been used, in the Hudson valley, for the manufacture of cement. It is usually found with a comparatively low dip towards the west. Chert is present in abundance.

Below the Onondaga limestone there is found a rather thin bed of brown-colored, banded and impure limestone. This is the equivalent of the Schoharie grit. It is high in iron, alumina and silica. In general appearance it somewhat resembles the Onondaga and for purposes of mapping and sections we have included it with the Onondaga. In its physical characteristics it gradually passes into the Onondaga limestone above and into the Esopus grit below.

The **Esopus** grit occupies a prominent part in the surface geology of this section. It has no economic value. It is usually difficult to determine the correct bedding of this formation owing to the great abundance of joint planes running in every conceivable direction. The rock is of a very even, dark gray color and fairly coarse grained. In the general topography of the region its exposures appear as smooth rounded elevations generally showing a scarcity of vegetation.

Directly below the Esopus is a body of dark gray-colored sandstones and shales accompanied by thin isolated beds of limestone. Owing to physical characteristics we have mapped this with the Esopus. It is distinguished from the Esopus, however, by the more distinct parallel bedding, by the finer grain and by the presence of fossils. This formation is, in most localities, covered by surface materials such as swamp deposits or under water. This is a portion of the formation which represents an extension of the Oriskany sandstone towards the east. Below this formation, and usually carrying in the higher layers several distinct bands of chert, is found the Port Ewen limestone, also an extension of the Oriskany formation. This formation closely resembles, in physical features, the New Scotland limestone and is often mistaken for that formation. The several distinct beds of the Port Ewen vary both vertically and horizontally in chemical composition. The percentage of silica is compara-

tively high; magnesia is present, ranging as high as 10 per cent. The thickness of the Port Ewen varies from twenty to thirty feet.

The **Becraft** limestone, the main source of lime for the manufacture of portland cement, in this section, is found below the Port Ewen with a thickness varying from thirty-five to forty-five feet. Physically it is rather sharply defined from the Port Ewen. It is found in massive beds sometimes accompanied by thin shale partings. These shale layers form a natural parting plane. Fig. 1 shows the quarry conditions where the shale parting planes

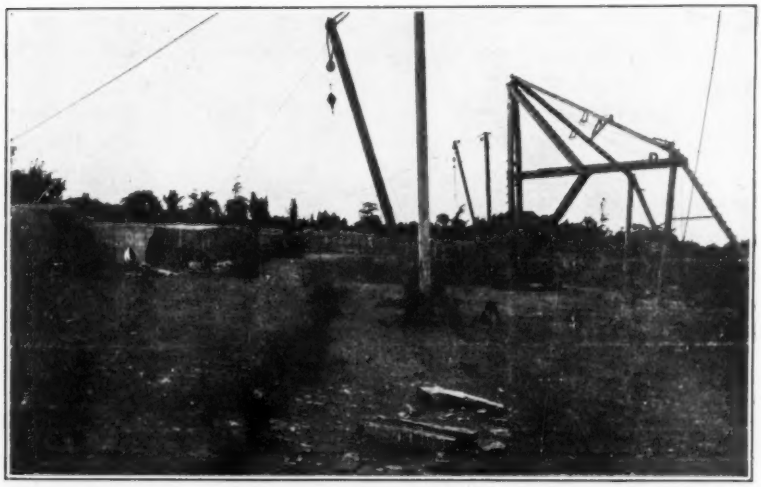


FIG. 1.

are prominently developed. A fresh exposure of the rock usually has a light gray color tinged with pink, the pink shade being derived from the iron-stained calcite of organic replacement. The Becraft limestone resists the action of the weather to a considerable extent and its exposures take a prominent place in the general topography.

The **New Scotland** limestone includes several distinct beds varying from a calcareous shale to a pure limestone. The shaly layers are apparently not suitable for the manufacture of port-

land cement. They are high in alumina, iron and magnesia and low in lime. Sulphur compounds are also somewhat abundant. The basal layers of the New Scotland may be recognized by the presence of several distinct layers of chert. Owing to the great resemblance of the New Scotland and Port Ewen they are sometimes mistaken for each other, but using the Esopus grit as a reference formation, there will be no difficulty in identification. The New Scotland limestone, comparatively speaking, does not resist the action of the weather and for this reason it is sometimes difficult to locate the outcrops owing to the presence of abraded or weathered material. The limestone carries an abundance of fossils. An average thickness for the New Scotland may be taken at seventy feet. Along with the Coeymans this formation has been used as a source of cement material.

The **Coeymans** limestone is a rather massive dark gray rock of rather regular composition although in places it is comparatively high in magnesia. It is prominently exposed above the Manlius limestone and while it does not resist the action of the weather, in regard to solution, as well as the Manlius, the absence of joint planes makes it a prominent capping over the rather easily mechanically disintegrated Manlius. The Coeymans limestone varies in thickness with an average of about forty feet. It is easily identified from the New Scotland, using the chert beds as a reference, and from the Manlius limestone by the rather sudden change in physical character of rock.

The **Manlius** limestone is found very prominently exposed along the base of the limestone ridge. Along the eastern border of the limestone ridge it is usually a member of the prominent, more or less exposed, syncline. The lower beds of the Manlius are of a massive character and carry an abundance of typical fossils. The middle and upper beds are comparatively poor in fossil remains and vary physically from a thinly laminated character to an extremely massive columnar structure. Joint planes are prominent to such an extent that the Manlius exposures are easily picked out in the topography of the region. Material from the laminated layers of the Manlius has a peculiar clear clinking sound when struck. The Manlius has a very irregular thickness with a range of thirty to fifty feet. It varies greatly

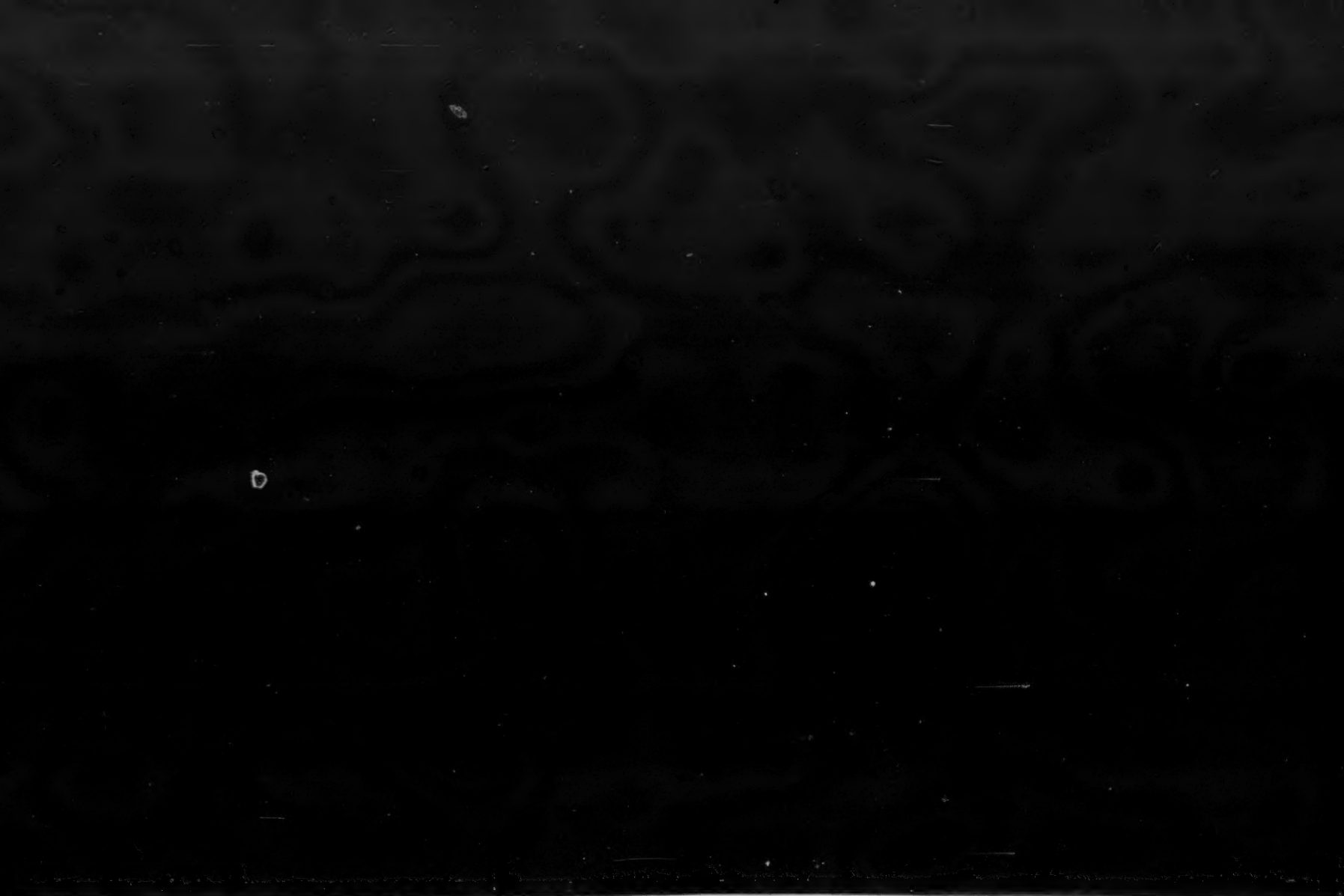
in composition, especially with reference to silica and magnesia. This formation has been used as a source of lime for cement.

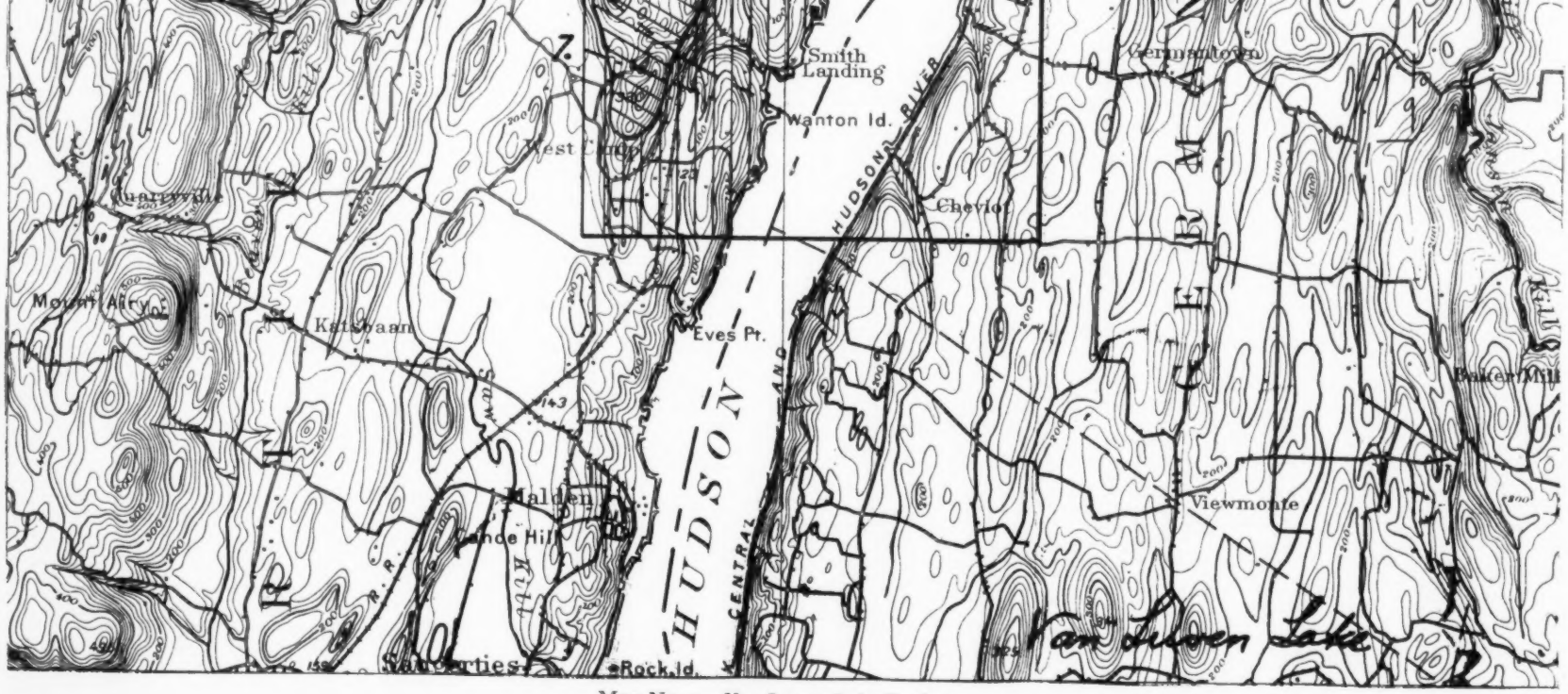
The **Rondout** limestone, known in the New York classification as the Rondout waterlime, is found directly below the Manlius. It has no economic value. It varies in thickness from several feet to a thickness where its admixture in the cement mixture would have to be taken into account. It may be distinguished from the Manlius by the brown color, due to weathering, and its massive character and lack of horizontal parting planes.

The **Cobleskill** limestone is a very thin bed of impure silicious limestone. It is economically in the same class as the Rondout and varies in composition from a pure limestone to a sandstone. It is not present as a continuous bed but thickens and thins from a few inches to several feet.

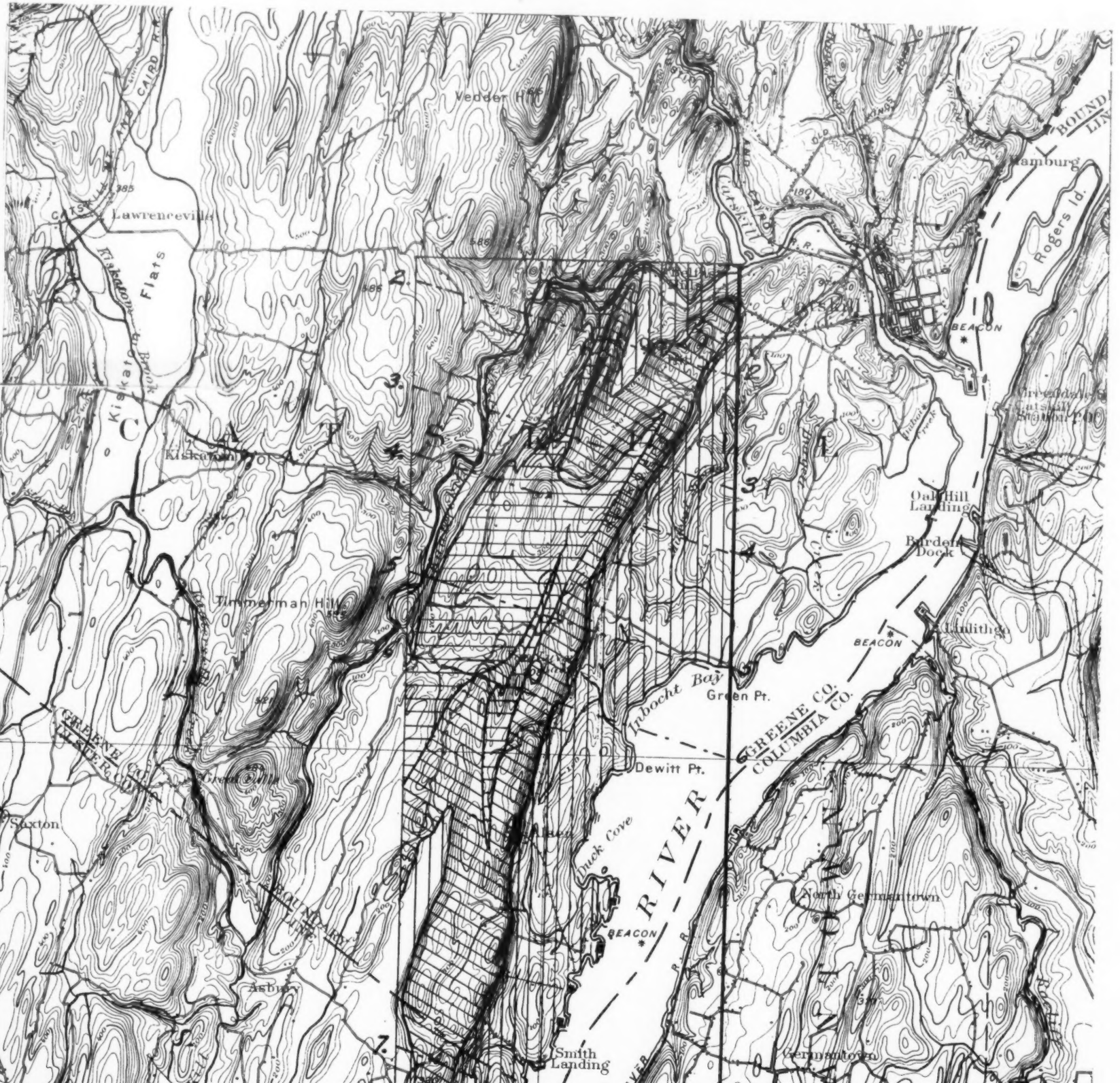
The **Normanskill** shales and sandstones, found usually to the east of the limestone belt, are in most cases covered by morainal deposits of clays. They are exposed prominently along the west bank of the Hudson river, in the bed of the Catskill creek, and at quite a few localities along the one hundred and two hundred foot contours, appearing as "islands" in the almost level clay deposits. They vary in composition especially with regard to alumina and silica. The shales are fairly high in alumina and will compare well with the clays as to silica. Usually they carry a lower percentage of lime than the clays. The sandstones, however, are rather low in alumina, high in silica, and usually carry a higher precentage of lime than the shales.

In the accompanying maps (Nos. 1 and 2) we have used a system of cross-hatching to designate the various formations. The classification is made with special attention to their physical characteristics. This classification, however, closely follows the usual palaeontological classifications. The vertical and horizontal cross-hatching represents, respectively, the Normanskill shales and sandstones and the combined Esopus grit and Oriskany. The diagonal cross-hatchings are used to designate the two limestone belts, the combined Onondaga and Schoharie at the west and the combined Cobleskill, Rondout, Manlius, Coeymans, New Scotland, Becraft and Port Ewen at the east.





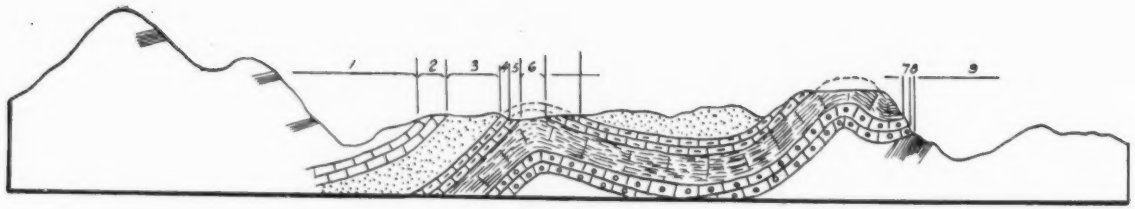
Map No. 2—Van Luven Lake Region.


Vedder Hill
Lawrenceville
Flats
Kiskatom
Timmerman Hill
Saxton
Asbury
Smith Landing
Germantown
North Germantown
Dewitt Pt.
Green Pt.
Inbocht Bay
Duck Cove
Oak Hill Landing
Burden Dock
Rogers Id.
Tivoli
BEACON
RIVER
GREENE CO.
COLUMBIA CO.

The reference points for the field examination of these deposits are the distinct Normanskill shales and sandstones at the base of the limestones, the Hamilton beds of brown, red and black shales and sandstones above the limestones, and the included mass of Esopus grit. The Onondaga, Port Ewen and New Scotland limestones have their chert layers and, therefore, we have a complete set of indicators for the location of the economic members. This statement is made on the assumption that the economic geologist will not be entirely familiar with the fossil remains and will, therefore, have to fall back on the physical characteristics.

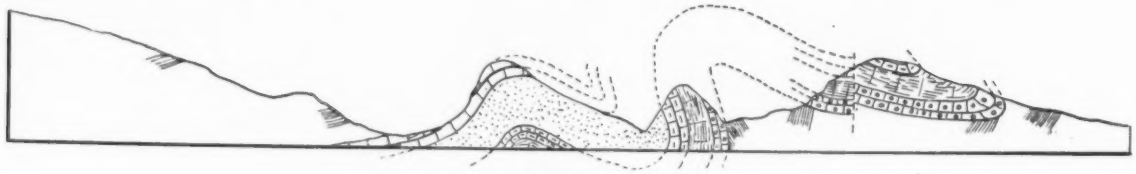
The commercial value of the productive beds has been more or less increased by the great amount of local folding and faulting. These beds have in many cases been brought to such a position that later erosion has placed them on the surface or very close to the surface. While the local folding and faulting is everywhere in evidence, at no place has it been extensive enough to throw any two physically distinct beds in contact. The character of the folds changes very suddenly along their strike. Each locality, to be properly understood, has to be studied independently and therefore the general scheme only of the folds is shown in the following sections (Sections 1 to 7).

The sections speak for themselves. The one persistent character that appears throughout the region and which is shown in these sections is the syncline along the eastern contact of the limestones. In the Van Luven Lake area this syncline is very sharp along sections 2, 3 and 4. This syncline gradually becomes less pronounced towards the south, with the exception that between sections 6 and 7 a series of very sharp local folds appear (Fig. 2) to again die out finally at the end of the limestone belt. Between this general syncline and the western contact of the limestone and the Normanskill deposits are usually a series of small simple folds. The greatest amount of displacement is along the eastern border. Between sections 6 and 7 the sharp folding and faulting has thrown into the productive area a considerable amount of waste material. This is well shown in Fig. 3 where the continuity of the productive layers is broken by a mass of slickensided, arenaceous limestone. Horizontal faults have in

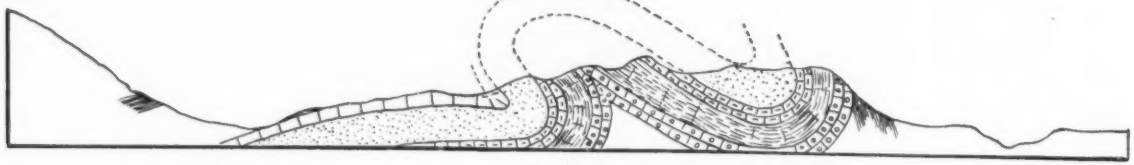


Section 1.

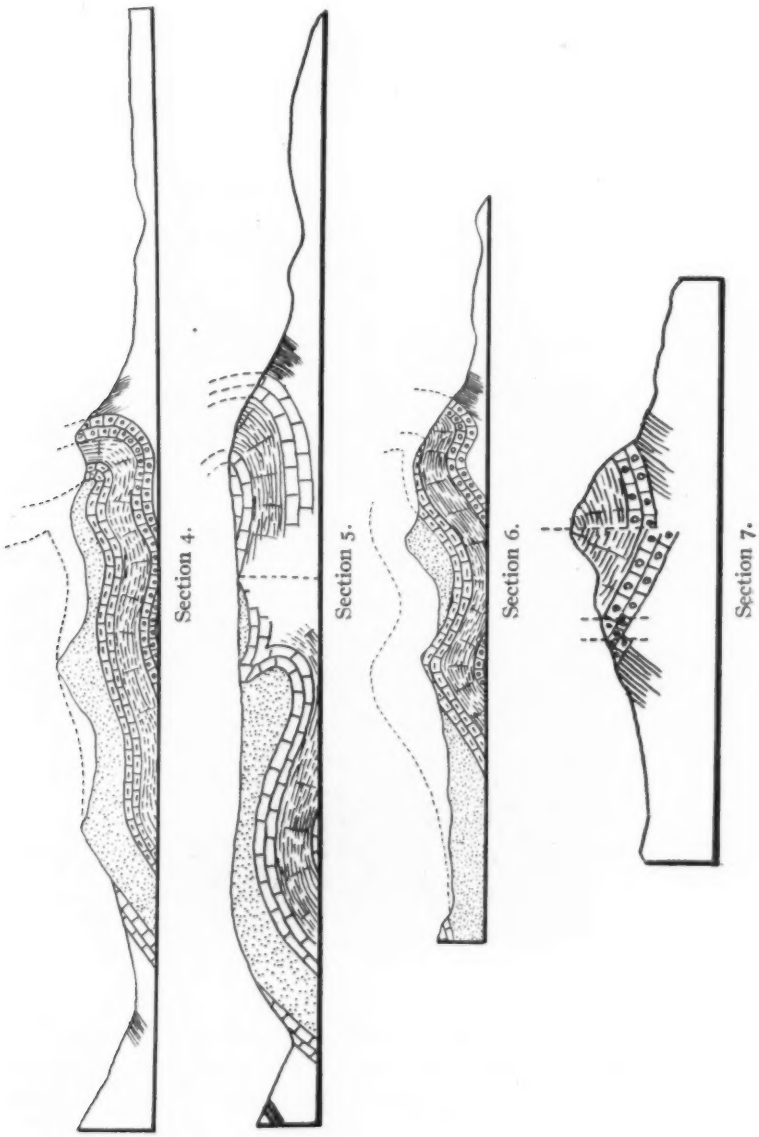
1. Hamilton—Marcellus.
2. Onondaga—Schoharie.
3. Esopus—Oriskany.
4. Port Ewen.
5. Becraft.
6. New Scotland.
7. Coeymans.
8. Manlius.
9. Normanskill.



Section 2.



Section 3.


Section 4.
Section 5.
Section 6.
Section 7.

certain instances thrown worthless material over a productive bed resulting in an excess of overburden (Fig. 4). The folds of the Black Lake region are not as pronounced and towards the north gradually pass into an almost level deposit. This flattening out

FIG. 2

towards the north is responsible for a better general condition as regards quarry locations. At the north, moreover, the supply of material is greatly increased by the greater area of the Onondaga limestone.

Throughout the southern section of the Van Luyen Lake area

the supply of high-grade material is absolutely limited; through the northern section of the same area it is limited by the methods of mining. With the introduction of underground mining, especially in the region between sections 3 and 6, inclusive, there

FIG. 3.

can be an unlimited production. There are many facts brought forward in favor of open-cut mining as compared with underground mining and yet in this region many of the present difficulties as encountered in open-cut mining could be forgotten and a steady production made throughout the year. The possi-

ble high cost of drilling would be cut by the steady production of a high-grade material, with no sorting, no handling of waste

FIG. 4.

rock, no loss of time during the winter months, and no handling of overburden.

TOMPKINSVILLE, N. Y.

THE CLEANING OF SHEET STEEL AND IRON FOR ENAMELING PURPOSES.[1]

By R. R. Danielson.

It is the consensus of opinion among enamelers that one of the prerequisites for successful enameling is cleanliness, especially as applied to the cleaning and pickling of the metal previous to application of the enamels. The term cleaning, as used by platers, however, is a comparatively new one to enamelers, whose recognized name for this same operation is embodied in the processes known as scaling and pickling. The word cleaning can reasonably be used to designate the operations necessary to remove the grease and the oxide of iron from the metals.

While the importance of this subject is thoroughly recognized by enamelers, comparatively little work of a systematic nature has been carried on, and in general the pickling or cleaning department runs according to the judgment of the pickler. Research work of this kind demands commercial conditions for true comparative results, and it is our intention merely to present some data on the various methods of cleaning and pickling as a guide for systematic investigations.

Cleaning may be divided into the following processes:

1. Removal of grease and dirt.
   - (*a*) Scaling.
   - (*b*) Cleaning compounds.
2. Removal of iron oxide.
   - (*a*) Sand blasting.
   - (*b*) Pickling with acids or acid compounds.
   - (*c*) Electrolytic pickling.
3. Neutralizing baths.
4. Drying of ware.

1. Removal of Grease and Dirt.

During the forming operations, especially in the case of sheet metal products, the metal becomes covered with grease and oil.

[1] By permission of the Director, Bureau of Standards.

If allowed to remain, these retard the action of the acid during pickling, and also cause trouble during the subsequent enameling process.

Scaling.—Under the old-established methods the scale is removed by the so-called scaling process, in which the ware is placed in a muffle furnace and heated at a temperature of about 1400° F for a period of from 5 to 10 minutes. To assist in the formation of a light scale which will separate easily from the metal, dilute acid, usually the discarded acid from the pickling tanks, is sprinkled on the ware just before it is placed in the furnace. Where the metal has rusted, this scaling method is especially advantageous, in that it tends to loosen the rust and facilitate the subsequent pickling.

The chief objection to scaling is the tendency of the metal to warp, due to the extra heating beyond that necessary in the enameling process, in the handling of this operation. This is especially true in the case of large, flat sheets. A second but minor objection is the formation of a heavy coating of oxide on the metal which may have been subjected to little mechanical working and hence no annealing, and which, therefore, is covered with only a slight film of oxide common to sheets fresh from the mills. This additional coating of oxide necessarily adds to the time required for pickling. For these reasons, and also as a possible source of saving in manufacturing costs, a large number of manufacturers have experimented with the so-called chemical cleaners with varying degrees of success.

Cleaning Compounds.—Analyses of a large number of chemical cleaners at the Bureau of Standards have shown them to be composed of one or several of the following materials:

Sodium hydroxide.
Sodium carbonate.
Ammonium carbonate.
Borax.
Trisodium phosphate.
Sodium silicate.
Resin in the presence of caustic, forming soap.
Soaps.

Other cleaners used, especially in the japanning industry, are naphtha and gasoline. It is questionable whether these wil serve the enameling industry, since they leave a light film of oi over which the water-suspended enamel will not flow evenly.

Another disadvantage of gasoline or naphtha is their inflammability, which makes their use undesirable in any industry.

The alkaline cleaners acting on a fatty oil should combine chemically with them, forming soaps. According to the explanation of soap chemists these soaps act on the remaining oil in a mechanical way to lessen the surface tension, thus separating the greases from the metal.

In the case of mineral oils, which are the basis of the usual lubricating oil, the action is principally a mechanical one. All the chemical cleaners lessen the surface tension and separate the oils from the metal. The globules rise to the surface of the bath where they may be skimmed off and then reclaimed for further use. Therefore, in removing mineral oils, where care is taken in separating the oil from the bath, the latter should serve for a period of weeks and even months with slight additions of cleaner from time to time. Eventually the accumulation of greases and dirt in the bath will limit its usefulness, and this, of course, is dependent on the conditions existing in the individual plant.

The following data were obtained in one enameling plant, using a cleaning bath over a period of approximately three and one-half weeks.

1st week.	New solution, 200 lbs. of cleaner in a 400-gallon tank.
	2nd day, no additions.
	3rd day, 5 lbs. cleaner.
	4th day, no additions.
	5th day, 15 lbs. cleaner.
	6th day, no additions.
	Total, 20 lbs. addition.
2nd week.	7th day, 15 lbs. cleaner.
	8th day, 20 lbs. cleaner.
	9th day, 12 lbs. cleaner.
	10th day, no additions.
	11th day, 12 lbs. cleaner.
	12th day, 2 lbs. cleaner.
	Total, 61 lbs. addition.
3rd week.	13th day, 7 lbs. cleaner.
	14th day, 12 lbs. cleaner.
	15th day, 18 lbs. cleaner.
	16th day, no additions.
	17th day, 15 lbs. cleaner.
	18th day, 2 lbs. cleaner.
	Total, 54 lbs. addition.

4th week. 19th day, 12 lbs. cleaner.
20th day, 20 lbs. cleaner.
21st day, no additions.
Total, 32 lbs. addition.

On the twenty-second working day a new solution was made up and the old solution was used as a preliminary bath for some exceptionally greasy ware. During this period approximately 2500 to 3000 sq. ft. of steel were handled each day. The original solution was made up of about one-half lb. of cleaner per gallon of water with an average addition each week of about one-sixth of this amount of cleaner. These data approximate the usual amounts of cleaner required for cleaning steel for enameling purposes, but exact amounts required can be determined only by experiment under actual conditions.

A prime necessity in the use of these chemical cleaners is that the bath be kept close to the boiling point, which is best secured by placing steam coils in the tank. Agitation, obtained either with a mechanical arrangement or by the introduction of a steam jet, accelerates the cleaning and is really essential to efficient work. It has been found that the use of electric current also accelerates the work, the time required for cleaning being remarkably lessened and better results being obtained. The general explanation for this is that the ware being made a pole, there is a generation of gas bubbles which act mechanically to carry off the grease. It is recommended by writers on this subject that the current be reversed, that is, the material to be cleaned be made the anode. One enameling plant has been very successful with this method of grease removal and has entirely eliminated scaling.

Another possible use of these cleaners is in the removal of enamel from pieces spoiled in the enameling process. The following data were obtained from work carried on in several enameling plants on tests of this kind:

(*a*) Two pounds of cleaner per gallon of water removed a vitreous enamel from kitchen ware in 36 hours without current.

(*b*) Two pounds of cleaner per gallon of water, bath kept at boiling point for 24 hours, removed a vitreous enamel in splendid shape.

(*c*) One-half pound of cleaner per gallon of water, with tempera-

ture of bath 180° F and reverse current at 6 amperes, removed a white enamel in 6 hours.

In these methods of removing enamel there is a possibility of considerable saving in the reclaiming of rejected ware in enameling plants, especially at the present price of steel and the high cost of labor in forming ware.

2. Removal of Iron Oxide.

Sand Blasting.—The next step in the cleaning process is the removal of oxide from the metal. The usual method of removing the oxide from large, sheet iron shapes, especially of heavy gauge, and from cast iron ware, is by means of a sand blast. This is a mechanical method in which the oxide is abraded from the surface of iron, which is left rough as compared with surfaces cleaned with acids. Whether this rough surface is better for enameling purposes is wholly theoretical, as both smooth and rough surfaces appear to enamel successfully in practice.

The use of steel shot and crushed steel is taking the place of sand for so-called sand-blasting purposes. Its chief advantage is the elimination of dust during the operation.

For cleaning metal for enameling, the sand-blast method has an advantage over pickling. The presence of acid in the metal during enameling is harmful, in that it causes blistering during the firing of the enamels. Sand-blasting also eliminates scaling or cleaning as it removes the slight film of oil and dirt as well as the oxide. It is, however, questionable whether sand-blasting on light-gauge metals or irregular shaped pieces would be successful.

Pickling.—Pickling is the process of chemically removing oxide from the metal so that the metal itself is exposed. It is usually accomplished by the use of sulphuric or hydrochloric acid solutions of concentration of 2 to 15 per cent by weight and at a temperature of from 25° to 80° C. Other reagents for pickling include hydrofluoric acid, and solutions of sodium acid sulphate or so-called niter cake.

It is the common theory that pickling is accomplished by the reaction of the acid on the iron or steel with the formation of an iron salt and hydrogen gas. The acid works its way under

the scale by dissolving a thin layer of metal, thus loosening the scale. The final separation of scale is sometimes aided by the pressure of hydrogen-gas bubbles formed during the solution. This action can be plainly seen on any piece of metal covered with a loose scale. Strong acids will dissolve the oxide to a certain extent but weak acids act on the iron alone, allowing the oxide to settle in the tank bottom as a brown sludge.

For most efficient action in pickling, considering minimum attack on sound metal, the acid strength should run between 2 and 4 per cent for sulphuric acid and about 3 to 5 per cent for hydrochloric acid. These limits represent maximum activity on average light scale, but where a heavy scale is encountered it may be necessary to increase the acid content to 10 per cent.

One of the main objections to a strong acid for enamel ware is the tendency for the metal to form blisters, either during the pickling process or during subsequent enameling operations. This is especially true of steels containing impurities. C. Treischel[1] states that a reduction in the acid content from 10 to 3 per cent, using sulphuric acid, decreases blistering enormously, in some cases from 40 to 2 per cent.

That a considerable saving in acid can be realized without materially cutting the time of scaling of ware covered with a normal amount of oxide is shown by the experience at one plant. Moreover, the quality of pickling was found to be much improved with the decreased acid content. The solution bath previous to tests contained an average of from 4 to 8 per cent of acid. To a tank containing approximately 300 gallons of water was added 104 gallons of 1.18 sp. gr. hydrochloric acid, giving an acid strength of 8 per cent. On the second day about 26 gallons of acid were added, bringing the acid content to about 6 per cent. No acid was added on the third day during which the acid content averaged 4 per cent, after which a new solution was made.

It was afterwards found from some trials that 52 gallons of acid to 300 gallons of water and an additional 26 gallons the second day kept the acid content at from 4 to 5 per cent, after which the tank was emptied. This gave a more uniform run of

[1] C. Treischel, *J. Am. Ceram. Soc.*, **2**, 774 (1919).

pickling at a saving of about 25 gallons of acid per week and a decrease in blistering during enameling.

During the last year or two necessity for saving acids and their increasing costs brought to the attention of manufacturers using the pickling process a substitute in the form of niter cake—a by-product of nitric acid manufacture.

Niter cake is an impure acid sulphate of sodium carrying a variable excess of sodium sulphate. Its acidity usually ranges from 28 to 44 per cent sulphuric acid, although the usual content is around 32 per cent. The cake usually contains some impurities such as small amounts of iron, alumina and silica and occasionally traces of arsenic or nitric acid.

Pickling with niter cake does not differ much from acid pickling, except that for best results it is essential that the bath be kept close to boiling temperature. In annealing practice it has been found advantageous to use a mixture of niter cake and sulphuric acid especially where speed in pickling is desired. The pickling capacity of 1 pound of niter cake is equivalent to 0.37 pound of 66° B. sulphuric acid. A mixture of niter cake and sulphuric acid is recommended by Corbett[1] for normal production, although in some cases the acid can be entirely replaced by niter cake. This agrees with the experience of one plant where successful pickling was accomplished by the use of 1 pound of niter cake per gallon of water kept at boiling temperature. The work, however, was principally on metal covered with very little oxide, as it had previously been put through a cleaning solution instead of the usual scaling process.

The following data, the result of successful tests over a period of several months, give some idea of a mixture suitable for enameling-plant pickling.

A typical run was as follows: The bath was made of 700 gallons of water with 275 lbs. of 66° B. sulphuric acid and 100 lbs. niter cake. This gave an acid content of approximately $5^1/_2$ per cent. The bath was then maintained at about this strength by the addition of about 30 lbs. each of sulphuric acid and niter cake daily. It is possible that the actual daily require-

[1] E. E. Corbett, "Pickling with Niter Cake," *Automotive Industries*, Dec. 26, 1918.

ment was high—due to the condensation of steam in the bath. This bath was used for a week when a new charge was made up. During this time approximately 3500 sq. ft. of metal was pickled each day. This bath was very active and ware that required from 10 to 30 minutes in a hydrochloric-acid bath of 6 per cent acidity was put through this mixture in from 2 to 4 minutes with excellent results. One disadvantage of niter, especially when used alone, is its short life as compared with acid. This is due to the addition of sodium sulphate as an unavoidable component of niter cake, which rapidly increases the solids in solution. According to Corbett,[1] it is wasteful to attempt to strengthen baths which have a specific gravity higher than 1.26 to 1.28, as acid at this point carries such a large amount of salts in solution that the activity of the acid has ceased.

The most satisfactory method of testing a pickling bath for acid strength is by titration of a 10 cc. sample of the acid against a normal solution of sodium hydroxide. The formation of a small permanent iron-hydroxide turbidity is taken as the end point. Each cubic centimeter of standard alkali solution represents approximately one per cent of free acid by volume.

The advantages of niter-cake solutions are saving in cost of pickling and absence of acid burning and etching when used. It is a material more easily handled than the sulphuric acid and if kept in a dry place will retain its original content of acid fairly well.

Essential conditions for efficient pickling are agitation and heating of the bath. Reactions are hastened if the temperature of the pickling bath is maintained at 160° to 180° F, and in the case of the niter cake boiling is highly desirable. The average enameling plant makes little use of agitation, although the sheet mills make use of it in all its various forms. The general methods of agitating are by means of steam outlets in the bath or by mechanical agitation of the ware or solution.

Steam agitation is wasteful because of the condensation of water in the bath and the difficulty of getting steam outlets to stand up in use. In mechanical agitation the ware may be raised and lowered in the bath by means of a steam or air hoist or the acid

[1] *Loc. cit.*

level may be raised and lowered by a plunger device in the bath. The former is used where the charge of ware is comparatively light and the latter where heavy charges are carried in the bath. Some modification of these methods could be easily applied to the enameling process, especially in those plants where standard shapes are put through, with a considerable saving in cost of pickling.

In order to eliminate the disagreeable fumes from pickling baths, use has been made of such materials as sugars, flours, soap-bark, etc., the material being sprinkled over the surface of the bath. These organic substances, due to their charring by the acid, form a blanket of charcoal and foam over the acid which retards the expulsion of the hydrogen gas and acid fumes. It is claimed by manufacturers of some of these compounds that the retention of the hydrogen gas in the bath accelerates pickling but experience of picklers apparently shows the contrary to be true. In a number of cases the use of these materials has been discontinued, due to the "killing" of the acids after their use.

Electrolytic Pickling.—This has been used to a considerable extent in the plating industry where currents of low amperage and voltage are obtainable. In this method the work is accomplished in a bath of a suitable electrolyte through which the current is passed. The ware to be pickled is placed as the cathode or anode in the bath. According to Rawdon,[1] when the metal is used as the cathode, the hydrogen liberated reduces some of the oxide and also aids mechanically in flaking it off. When the steel is made the anode, the oxygen liberated mechanically detaches the oxide, which later might dissolve in the electrolyte.

Thompson[2] states that work which required 43 minutes for pickling in a 4 per cent sulphuric acid bath at boiling temperature was pickled in an electrolytic bath in 5 minutes with a current of 9.5 amperes and 2.7 volts.

He states the advantages of electrolytic over chemical pickling as follows:

[1] H. S. Rawdon, Bur. Standards, *Circ.* **80**, "Protective Metallic Coatings for the Rustproofing of Iron and Steel."

[2] M. D. Thompson, *Trans. Am. Electrochem. Soc.*, **31**, "Electrolytic Pickling of Steel" (1917).

1. Speed of pickling.

2. Saving in cost over acid—estimates cost at $^1/_4$ that for acid.

3. Evenness of pickling, as the metal is not attacked, the only action on the metal being mechanical, the chemical action being confined to the scale.

One stove-manufacturing company has experimented with current in their pickling baths. They found that a current of 6 amperes in a bath of sulphuric acid (1 part acid to 4 parts water) cut the time of pickling with a saving in cost of acid. The enameling industry has not yet made use of this method of pickling to any large extent, but from results obtained in other industries, it should be worthy of investigation.

Neutralizing Baths.

In all but gray-ware enamels, it is very essential for successful enameling that all traces of acid be removed from the metal. The mottling in the so-called gray or granite ware is accomplished by the rusting of the metal due to the presence of iron sulphate, so that no attempt is made to neutralize the acid, the ware simply being passed through rinse waters and then dried, or left under water until ready for dipping. The iron sulphate in the presence of air forms iron hydroxide, which appears as rust spots on the metal. In the burning of the gray enamel these spots change to iron oxide which flux the enamel and cause black spots wherever the rust spots occur. These black spots against the gray background give the mottled appearance.

For all other wares the presence of acid on the steel where the usual ground coat is employed leads to many troubles in enameling, such as irregular draining of the enamel and blistering, so that especial care must be taken to neutralize the remaining acid. This is carried out by immersing the ware in a weak alkaline bath made up by dissolving one pound of soda ash in about 25 gallons of water. A better neutralizing agent is one of the soda-ash soda-caustic compounds found on the market. These compounds consist of approximately 2 parts of caustic soda to one part of soda ash and are much more effective than common soda ash. Similar results should be obtained, however, by adding 12 lbs. of caustic soda and 6 lbs. of soda ash to about

400 gallons of water. A decided advantage of such a mixture, aside from its greater neutralizing power, is that such a solution will be effective over a period of several days whereas an ordinary soda bath will become ineffective after one-half to one day of use.

To facilitate rapid drying of the ware and consequently as little rusting as possible, the alkaline bath is kept close to the boiling temperature.

Drying.

Drying is accomplished by passing the ware into driers heated from 150° to 230° F. These are usually heated by waste heat from the enameling furnaces, gas burners or by steam coils.

Waste heat is usually provided by passing air through a flue between an inner and outer lining in the stacks of the furnaces. A blower is placed between the stacks and driers, pulling the air through the flue and passing it on to the drier. The essential points in this system are: (1) that the stack be properly lined to prevent the products of combustion from passing into the waste-heat flue; (2) that proper aprons be provided over the openings to the waste-heat flue to prevent the products of combustion from being drawn in from over the top of the stack. The products of combustion, if allowed to pass over the drying ware, may deposit soot or cause rusting of the metal, either of which would undo the work of cleaning and pickling.

Gas driers are successful, especially where a conveying system is used through the drier and care is taken to obtain complete combustion. The products of combustion from a smoky gas-flame are as harmful as those considered in the use of waste heat.

Steam coils furnish exceptionally clean drying conditions but drying in this way is apt to be somewhat slower and less thorough when ware with closed beads is being dried.

Summary.

A brief summary of the methods used in the cleaning and pickling of metals brings to view a varied set of processes for accomplishing the work. While enamelers have long realized the extreme importance of careful cleaning and pickling, it is readily seen that much can be borrowed from the practice of related industries with

great possibility for decreased costs and increased output. Where the conditions in plants have permitted, enamelers have taken advantage of these opportunities and have instituted the use of new methods, such as removal of grease with chemical cleaners and pickling with acid substitutes, with very satisfactory results.

BUREAU OF STANDARDS,
WASHINGTON, D. C.

PRODUCTION OF SELENIUM RED GLASS.

By F. A. Kirkpatrick and George G. Roberts.[1]

The production of red glass by the use of metallic selenium and selenium compounds as the coloring agents has been practiced in the United States and in Europe for many years. The methods have been kept secret and only a few manufacturers have succeeded in producing selenium glass of satisfactory quality. The various steps in the process, from the compounding of the batch mixture on through to the annealing of the ware, require very careful control.

In addition to the proper degree of color absorption, each of the different kinds of products, such as lenses, globes, bulbs, sheet glass, etc., must possess those physical properties which permit its use for the intended purpose. For example, a lantern globe must be free from such defects as seeds, stones, and cords, and must have sufficiently low viscosity and fusibility to allow it to be blown in molds easily and quickly. The finished globe must be resistant to rupture on sudden heating and cooling and to the agencies of weathering. In order that it may possess these properties, the glass must contain such constituents as lime, zinc oxide and boric oxide. If a red color cannot be produced in such a glass by the use of selenium, some other coloring agent as copper or gold would have to be employed.

As a coloring agent selenium has certain advantages over copper and gold. It is a cheaper coloring agent than gold. With proper manipulation selenium always gives the desired color while copper-red glass frequently comes from the pot spangled and spotted—due to the different degrees of reduction of the copper compounds. Selenium produces a very pure red but other coloring agents produce red colors which allow light to pass in other parts of the spectrum.

In a preliminary study of the methods of production of selenium glass, several melts were made at the Pittsburgh Laboratory of the

[1] By permission of the Director, Bureau of Standards.

Bureau of Standards. It is believed that the results obtained thus far will be of interest to glass manufacturers.

Two kinds of glass were made, a soft-working zinc-alkali glass and a plate glass. The formula and batch weights of the zinc glass were as follows:

$$\left.\begin{matrix} 0.239\ K_2O \\ 0.408\ Na_2O \\ 0.353\ ZnO \end{matrix}\right\} 2.26\ SiO_2.\ \ 0.0145\ B_2O_3 \left\{\begin{matrix} 0.0142\ CdS \\ \\ 0.026\ Se \end{matrix}\right.$$

	On basis of 100 sand.	On basis of 100 batch.
Sand	100.0	53.70
Potash	30.3	16.25
Soda ash	30.3	16.25
Zinc oxide	21.2	11.37
Cadmium sulphide	1.51	0.81
Selenium	1.51	0.81
Borax	1.51	0.81

The formula and batch weights of the plate glass were as follows:

$$\left.\begin{matrix} 0.427\ Na_2O \\ 0.549\ CaO \\ 0.024\ MgO \end{matrix}\right\} 2.62\ SiO_2 \left\{\begin{matrix} 0.015\ CdS \\ \\ 0.020\ Se \end{matrix}\right.$$

	On basis of 100 sand.	On basis of 100 batch.
Sand	100.0	62.6
Soda ash	29.8	18.6
Hydrated lime	27.7	17.3
Cadmium sulphide	1.35	0.85
Selenium	1.04	0.65

The compositions of the raw materials used were as follows:

Material.	Principal constituents.	Per cent.
Sand	SiO_2	98.62
Potash	K_2O	54.05
	Na_2O	2.70
Soda ash	Na_2O	57.32
Zinc oxide	ZnO	98.14
Borax	B_2O_3	49.35
	Na_2O	21.54
Cadmium sulphide	CdS	100.00
Metallic selenium	Se	100.00
Hydrated lime	CaO	70.42
	MgO	2.19

The materials were weighed out in 30-pound batches, passed through a 12-mesh screen, and mixed by pouring from one mixing can to another several times. The cadmium and selenium were pre-mixed with a small portion of the batch in order to prevent loss of any considerable portion of these coloring agents during the process of mixing.

The glass was melted in a 30-pound covered "monkey pot," shaped like those used in the factories for blown- and pressed-ware glass. The pot was set in a small down-draft furnace fired by gas and compressed air and brought slowly to a temperature of 1400° C.[1] The batch was then introduced into the pot in three fills, within a period of about three hours. After the filling had been completed the glass was allowed to fine for five hours. After standing three hours longer the pot was "taken down," that is, the door was taken out and the glass allowed to cool to a sufficiently low temperature for working. On account of the small size of the pot the glass could be cooled quickly and was ready for working in a half-hour after "taking down." Two or three hours were required for working out the glass.

Shortly before working out, the melt should be skimmed to remove impurities which have collected on the surface. The skimmed glass is saved and used as cullet in the next melt. Metallic selenium melts at 217° and boils at 675°, forming a red-yellow vapor. Hence it escapes readily from the batch during the melting and fining periods and it is necessary that the pot door be sufficiently covered with wet clay to prevent the escape of the coloring agent. If any fumes at all are observed to escape, it is known that some of the selenium is being driven out of the glass. After the selenium becomes incorporated with the glass, probably in colloidal suspension, it is retained permanently, provided the temperature is not raised above 1400°. It should be noted that the time required for the several operations would be much longer in actual practice where larger pots are used.

The glass was gathered on punties and worked by three methods: (1) Pressing in a mold; (2) Blowing in a mold; (3) Blowing and working "off-hand," that is, without the use of a press or mold. The pressed specimens were discs one inch in diameter

[1] All temperatures given in this paper are in degrees Centigrade.

and one-eighth inch thick, and signal lenses three inches in diameter. The blown specimens were salt shakers. The "off-hand" specimens were bulbs and vases. By the use of these three methods, the manipulations necessary for bringing out the color were determined.

A description of the different steps in these processes, the time required for each step, and the results obtained, are tabulated as follows:

METHOD 1.—PRESSING IN A MOLD.

ZINC-GLASS LENSES.

Time in seconds from instant of gathering.	Step in process.
0 to 2	Glass gathered from pot.
2 to 20	Glass marvered (rolled on iron plate).
20 to 40	Lens pressed in mold.
40 to 60	Lens allowed to cool.
60 to 120	Lens flashed in glory hole.[1]
120 to 130	Lens allowed to cool.
130	Lens placed in lehr.

The temperature of the glory hole was 680° and that of the lehr 580°. After all of the glass had been worked out of the pot, the fire was turned off in the lehr and the lenses were allowed to cool 36 hours. They came from the lehr deep-red in color.

METHOD 1.—PRESSING IN A MOLD.

PLATE-GLASS DISCS, PROCEDURE A.

Time in seconds from instant of gathering.	Step in process.
0 to 2	Glass gathered from pot.
2 to 60	Glass cooled in air-blast to about 400°.
60 to 90	Glass flashed in glory hole.
90 to 100	Glass pressed in mold
100 to 110	Disc put into lehr.

[1] In glass working the term "flashed" means heated and softened in a flame or in a special furnace, under either oxidizing or reducing conditions. The term "glory hole" refers to a small furnace having one or more circular openings, 1 to 15 inches or more in diameter, through which the flames are allowed to escape and in which the ware is heated or "flashed" to soften it for working, to give it a "fire polish," or for some other purpose.

The temperature of the glory hole was 1200° and that of the lehr 500°. After 36 hours in the lehr the discs were removed and found to possess a good red color.

METHOD 1.—PRESSING IN A MOLD.
PLATE-GLASS DISCS, PROCEDURE B.

Time in seconds from instant of gathering.	Step in process.
0 to 2	Glass gathered from pot.
2 to 4	Glass carried to press.
4 to 14	Disc held in mold.
14 to 74	Disc allowed to cool in air.
74 to 254	Disc flashed in glory hole.
254 to 264	Disc placed in lehr.

The temperatures of the glory hole and of the lehr were the same as in Procedure A. The discs were yellow in color. They absorbed the blue light of the spectrum and allowed the other colors to pass.

METHOD 1.—PRESSING IN A MOLD.
PLATE-GLASS DISCS, PROCEDURE C.

Time in seconds from instant of gathering.	Step in process.
0 to 2	Glass gathered from pot.
2 to 4	Glass taken to press.
4 to 14	Lens pressed in mold.
14 to 194	Lens flashed in glory hole.
194 to 204	Lens placed in lehr.

The glory hole and the lehr were at the same temperatures as used in Procedure A. The color of the lenses when taken from the lehr was a faint yellow.

A study of the four working schedules given above shows that a red color was obtained by use of the first two only. In these two procedures the glass was cooled immediately, after gathering, from the melting temperature to a lower temperature of from 400° to 700°. It appears to be this cooling process which brings the selenium into the proper state of dispersion for the subsequent development of the red color by reheating, or flashing. The physical processes which take place are no doubt

similar to those which bring out the color in gold-ruby glass, in which it is supposed that on cooling the glass from the melting temperature some of the gold exists in the form of nuclei, which, on reheating, serve as centers of growth and become large enough to give the visible effect of red color.

METHOD 2.—BLOWING IN A MOLD.

Salt Shakers, Procedure A.

Time in seconds from instant of gathering.	Step in process.
0 to 2	Glass gathered.
2 to 30	Glass blown and worked to shape in iron blocks.
30 to 130	Glass bulb allowed to cool until dark (about 400°.)
130 to 200	Glass bulb flashed in glory hole.
200 to 230	Salt shaker blown and held in mold.
230 to 240	Salt shaker placed in lehr.

METHOD 2.—BLOWING IN A MOLD.

Salt Shakers, Procedure B.

Time in seconds from instant of gathering.	Step in process.
0 to 2	Glass gathered.
2 to 10	Glass blown and worked in iron blocks.
10 to 20	Glass bulb taken to glory hole.
20 to 35	Glass bulb heated in glory hole.
35 to 45	Salt shaker blown in mold.
45 to 70	Salt shaker held in opened mold.
70 to 80	Salt shaker placed in lehr.

The temperature of the glory hole was 1200°. The temperature of the lehr was 500° in Procedure A and 600° in Procedure B. It is noted that in Procedure A the glass was allowed to cool after gathering for a period of 130 seconds, while in Procedure B the period of cooling was only 20 seconds. In the first case a good red color was obtained and in the second only a light yellow color.

METHOD 3.—"OFF-HAND WORK."

Decanter-shaped vases, 6 to 12 inches in height, were made by the following method:

Time in seconds from instant of gathering.	Step in process.
0 to 3	Glass gathered on punty.
3 to 8	Glass-bulb blown and swung to length.
8 to 30	Bulb marvered.
30 to 40	Bulb blown to a larger size.
40 to 45	Bulb swung to length.
45 to 50	Bulb taken to work bench.
50 to 60	Neck cut in bulb.
60 to 75	Bulb swung to length.
75 to 90	Bottom of bulb softened in glory hole.
90 to 110	Vase "gotten to shape" by allowing it to stretch and by pressing the bottom against an iron plate.
110 to 125	Bulb of vase blown to a larger size.
125 to 140	Bottom shaped by pressure of tool.
140 to 150	Vase heated in glory hole.
150 to 180	Bottom again "gotten to shape."
180 to 185	Bottom of vase "stuck up" onto another punty.
185 to 225	Top of vase heated in glory hole.
225 to 230	Vase swung and revolved to straighten neck.
230 to 250	Vase rotated on punty and top of neck flared with tools.
250 to 270	Vase allowed to cool to just below red heat.
270 to 275	Vase broken off punty.
275 to 280	Vase placed in lehr.

The temperature of the lehr was 600° and that of the glory hole 1200°. Vases were made of both the zinc glass and the plate glass, and came from the lehr with a beautiful, deep red color. The plate-glass vases tended to develop a sealing-wax red color, due probably to a crystallization of one of the forms of silica. This result was not obtained in the zinc-glass vases which, on prolonged and intense heating, became only deeper in color. The zinc glass, however, when heated for 30 minutes at a temperature of 900°, became crystalline as do most glasses under such conditions.

It is noted from the schedule that in making the vases the glass was allowed to cool for 90 seconds after the time of gathering, before it was reheated. This allowed the small particles of se-

lenium to assume the proper degree of dispersion at the right time. At this time the glass was only lightly tinged with color, but the color became deeper with the successive heatings and coolings that occurred in the process.

On account of the small size of the pot used in melting, only small amounts of the glass could be obtained free of seeds, stones, and cords. These defects could no doubt be overcome by the use of larger pots.

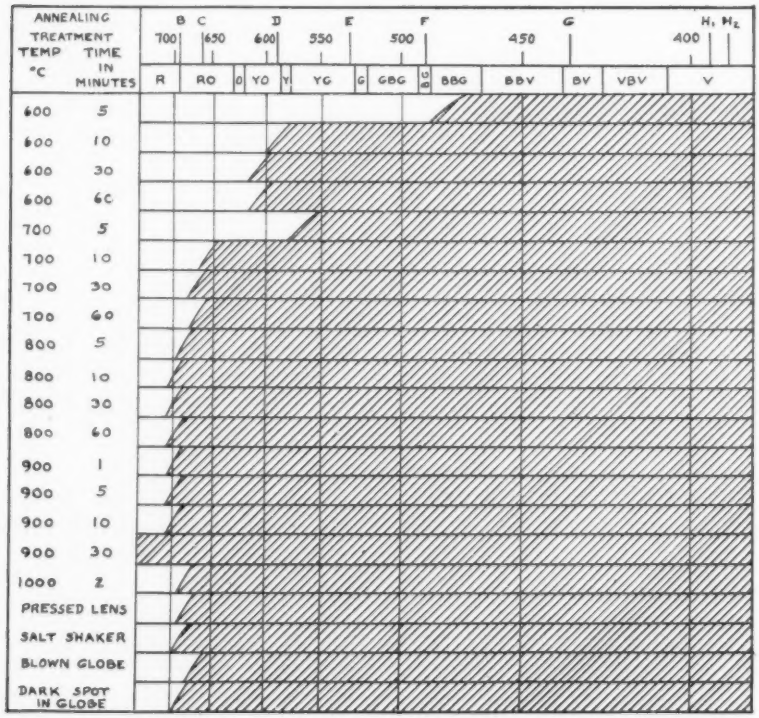


FIG. 1.—Effect of colored zinc-glass specimens on prismatic solar spectrum.

A number of the specimens were examined with a small direct-vision spectroscope. The results are shown in Figs. 1 and 2. The scale at the top represents the wave lengths in millimicrons ($m\mu$), the positions of the Fraunhofer lines, and approximately,

of the colors of the prismatic solar spectrum. The colors and combinations of colors are denoted by the first letters of the words. At the left of the diagrams is given a description of the kind of glass and the treatment received. The shaded portions of the diagrams represent that portion of the spectrum in which all of the light is absorbed, while the unshaded portions represent that part in which the light is transmitted. The line of division between the shaded and the unshaded portions is sloped to indicate a partial transmission of light. Unless otherwise noted the specimens were discs one inch in diameter and one-eighth inch thick. These were made by pressing by the method given under

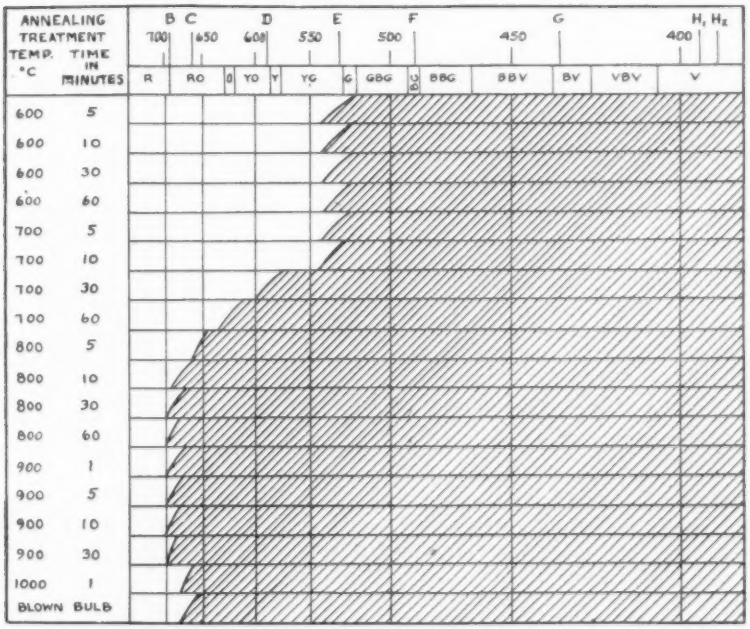


FIG. 2.—Effect of colored plate-glass specimens on prismatic solar spectrum.

"Method 1, Pressing in Mold, Plate Glass Discs, Procedure B." They were then brought slowly to a temperature of 400° and heated in a furnace at the temperatures and for the lengths of time indicated.

In conclusion we may say that the experience gained in carrying out the foregoing experiments has brought to our knowledge several essential features of the process of making selenium red glass. Good red colors were produced in the zinc glass by the use of 0.8 per cent each of borax, cadmium sulphide, and metallic selenium, and in the plate glass by the use of 0.65 per cent of selenium and 0.85 per cent of cadmium sulphide. The two most essential steps in the process are: first, the door of the pot must be securely closed during the filling and fining periods to prevent escape of the selenium by volatilization; second, the glass must be allowed to cool a sufficient length of time immediately after gathering, usually from one-half to one minute.

In the pressed ware the red color was best developed by heating, after pressing, for a period of one to five minutes at a temperature of 900°. The ware blown in molds sometimes developed its color before being placed in the lehr, and at other times after being placed in the lehr. The "off-hand" ware developed its color during the working before being placed in the lehr.

There was brought forcibly to our notice the importance of the method of working, in producing selenium red glass. The composition of such glasses had been known for a considerable length of time but success in making the glass was attained only by complete practical experiments in which were carried out all of the processes of manufacture from compounding the batch mixture to the final annealing of the ware.

Bureau of Standards,
Washington, D. C.

CERAMIC ABSTRACTS.

General.

Acid test for brick as a road material. W. FAWCETT. *Brick Clay Record*, **55,** 666–7 (1919).—The U. S. Bureau of Public Roads has started investigations to determine whether a limit should be placed on the size of motor trucks, whether improvements of springs or redistribution of weight is desirable and whether for the salvation of our roads the larger-size pneumatic tires should be substituted for solid tires. For initial tests a novel apparatus which registers the impact of the front and rear wheels of a truck passing over it is used. With the above data in hand it is their object to exert upon a road surface precisely the same kind of impact that is exerted by motor trucks. The machine embodies an unsprung weight together with a sprung weight just as in the case of a motor truck. The entire weight is raised by means of a cam and is allowed to drop a great number of times so that the impact will be exerted on the same spots. Continued impact will be kept up until noticeable failure occurs and it will be possible to deduce accurately just how many vehicles per day any designed type of road will withstand when laid on a known kind of sub-grade. H. G. SCHURECHT.

How hand-molded brick are made in England. J. W. OVEREND. *Brick Clay Record*, **55,** 681–3 (1919).—Although machinery has superceded the hand in making brick, there are yet quite a number of firms in England who make brick, chimney-pots, etc., by hand. Clots of clay are taken from the mill by the pug boy to the molders who throw the clay in the mold, which is an oblong box having two sides and two ends, the size being $10'' \times 5'' \times 3''$, in which the brick are roughly molded. The brick are then either sand- or slop-molded. In the sand molding the molds are sanded each time and, since the molder never parts with this mold but sends each green brick away on a pallet, it is termed "pallet-molding." In the other system the mold is dipped into water each time and the mold and brick taken away together.
H. G. SCHURECHT.

Micaceous or schistose clays. M. S. SYLVESTER. *Pottery Gaz.*, No. 508, 1078 (1919).—Sylvester, who was commissioned to prepare the highly porous water jars (gargoulettes) at Constantine, Algeria, attempted to prepare same by the addition of sand, sawdust, powdered charcoal and rock salt to the micaceous Constantine earths but was unsuccessful. Tests showed that the presence of mica renders the material impervious to moisture when baked and hence porous water jars could not be made from this material but the clay was well adapted for impervious tile. The porous French tile become rapidly

moss grown, owing to their high porosity, whereas the Constantine tile preserve their pink color. This impermeability is more apparent in pottery made from this clay and it is therefore unnecessary to glaze this pottery to make it impervious to water, even with ware of $1/8''$ thickness. Argillaceous mica, found in coal, is mixed with excessively plastic clays of poor drying properties and made into brick. H. G. SCHURECHT.

Phenomena of clay plasticity explained. R. F. MACMICHAEL. *Brick Clay Record*, **55**, 677–80 (1919).—The strength of clay, whether plastic, dry or burned, is due to molecular cohesion of the clay particles themselves. The property of cohesion is illustrated by Swedish gauges. These gauges are pieces of hardened steel the ends of which are accurate and true. When the ends of two of these gauges are carefully cleaned and placed together in such a manner as to exclude the air, they will be found to cohere with considerable force (as high as 35 lbs. per sq. in. when tested in a vacuum). If the surfaces are wetted with oil, the gauges fall apart just as water causes clay grains to separate. Plasticity results from the balancing forces of cohesion and disruption. Fluids other than water may be used to produce plasticity in clay. Organic matter, soluble salts and colloids, except as the latter are considered to be merely very fine, insoluble particles of the clay itself, are not essential to plasticity. H. G. SCHURECHT.

Note on forced-draft firing in a periodic kiln. R. K. HURSH. *Clay-Worker*, **72**, 322–4 (1919).—The use of mechanical draft has developed rapidly in boiler and other operations and its use with kilns is now commencing. Mechanical draft may be induced by drawing air through the kiln or by forcing by pressure under the grates. In induced draft the hot products of combustion are handled by the fan, which tends to become deteriorated thereby, although in some cases the gases are cooled before they reach the fan. In forced draft cold air is supplied under pressure beneath the grates and, since the air is cold, the volume of gas to be handled by the fan is less and hence a smaller fan may be used. Mechanical draft overcomes the difficulty of a cold stack and sluggish draft and provides ample draft during water-smoking. The application of forced draft to periodic kilns has, in many cases, reduced both the time of firing and fuel consumption. A heat balance was made on a 26-foot down-draft kiln, using forced draft, air being furnished at a pressure of $1^1/_4$ to $1^3/_4$ inches water gauge. The following results were obtained: (1) The fuel consumption per sq. ft. of grate area per hour was much higher than obtained normally. (2) The greater fuel consumption permitted a more rapid increase of the kiln temperature and allowed the use of a smaller grate. (3) The composition of the flue gases showed large variations in the amount of carbon-dioxide in the gases—probably due to short firing intervals. (4) Carbon monoxide present in the gases was due to insufficient mixing of the air and gases. A larger combustion space above the grate would remedy this to some extent. (5) There was a lag in the temperature of the bottom of the kiln during the early part of the burn but

at the end of the burn the top and bottom temperatures were the same. The following data were obtained:

Number of bricks set	66,000
Weight of bricks set	200.5 tons
Weight of burned bricks	162.5 tons
Weight of coal used	55,835 lbs.
Weight of coal per M bricks	846 lbs.
Weight of coal per ton bricks	343.6 lbs.
Length of burn	123 hrs.
Maximum temperature, top of kiln	1,940° F.

The fuel consumption was below the average for this type of burn—due largely to the short duration of the burn, made possible by the use of forced draft. H. G. SCHURECHT.

Some aspects on ball-mill grinding. L. BROWN. *Brick Clay Record*, **55**, 322 (1919).—Ball mills of different types vary as to efficiency. At the Lenox Pottery cylindrical mills lined with porcelain blocks are used. The mills are six feet long and five feet in diameter and hold a batch of 4,000 lbs. of dry material. The most important factors in grinding are: (1) Effect of time in grinding; (2) Weight of flint pebbles and their wear; (3) Measurement of water; (4) Record of revolutions of mill. Clay substance requires only enough grinding to mix it thoroughly with the coarser ingredients, which must be thoroughly ground before the clay is added. By grinding the clay substance too long it is possible to destroy the working qualities of the body. Indicators to record the number of revolutions are placed on the mills and with the aid of these the time of grinding is kept constant.

H. G. SCHURECHT.

Geological.

Preliminary report on the mineral resources of the United States in 1918. U. S. GEOL. SURVEY. Aug. 7, 1919.—Tabulated statistics of the clay and clay products industry of the United States are contained in this publication which is the first of a new class of Survey reports. E. D. ELSTON.

Refractories.

The magnesite industry in the United States. W. C. PHALEN. *Mining and Sci. Press*, pp. 295–298, Aug. 30, 1919.—Conditions of the magnesite industry are briefly treated. The mineral magnesite is widely distributed in California, occurring in 13 counties, the most important deposits being located in Tulare, Santa Clara, Napa, and San Benito Counties. In the State of Washington there are some deposits in Stevens County. It is interesting to note that the California magnesite is of the amorphous variety and the greater part of it occurs in veins or lenses in massive serpentine.

The thickness of the masses varies from 30 feet to mere stringers and gash veins which are too thin to work. The Washington magnesite is crystalline and occurs as massive beds in sediments consisting of dolomite, shale, and quartzite which have been intruded by basic igneous rocks. The reserves of the Washington magnesite are greater than those of California. The main use of magnesite is as a refractory for lining open-hearth steel furnaces and in lead, copper, and electric furnaces. Some magnesite is used for medicinal and chemical purposes. California magnesite has been employed in making sulphite paper-pulp but dolomite has largely replaced it for this purpose. Other uses are as follows: in fire-resisting magnesia paints and as a non-conducting material for boiler and pipe coverings, also for the manufacture of flooring cement. Crystalline magnesite has long been used for furnace bottoms, the Austrian magnesite containing iron oxide in sufficient amount to make it set well thus forming a hearth capable of resisting to a great degree erosion by molten steel. The Washington magnesite, however, does not contain enough iron oxide, necessitating the addition of this material. Although higher in silica and lime than the Austrian magnesite, the specifications regarding these substances and iron and alumina have been met and the Washington material is now of great importance. The amorphous variety of magnesite is not so satisfactory as the crystalline for refactories, due to the lack of iron. Some of the California magnesite which contained iron oxide in small amounts was used for refractory material but not to any great extent. The main use of the amorphous variety is for flooring materials. Dead-burned dolomite has been used as a substitute for magnesite in refractory furnaces but statistics showing the extent of this substitution are not available. Brief statements concerning the methods of mining magnesite and calcining the ore are given by Phalen and comparison is made between these methods in California and in Washington. E. D. ELSTON.

Qualities, composition and fabrication of silica bricks. *Genie civil*, **74**, No. 2, Jan. 11, 1919.—The best measure of the correct silica content with respect to refractoriness is given by the falling apart of small pyramids, constituted by the material of which the bricks are made plus 6% Fe_2O_3. The life of bricks increases with the SiO_2 content. Al_2O_3 increases fusibility. CaO does not noticeably increase fusibility when used up to 2%. Porosity has great bearing upon the life of bricks, the most desirable results being obtained with a total volume of voids of 18%. Swelling of bricks under influence of heat is greater, the coarser the grain. The rock should be ground so that larger particles pass No. 8 or 10 sieve. Best results are obtained by burning until nearly all the SiO_2 is changed to cristobalite, thus reducing swelling and shifting in the masonry. The writer thinks that the continuous kiln may be suited for burning silica bricks. C. TREISCHEL.

The preparation of raw materials for and the manufacture of glass-house pots. B. J. ALLEN. *J. Soc. Glass Tech.*, **3**, 78–93 (1919).—It is claimed

that inferior fire clays can usually be increased greatly in quality by deflocculation and precipitation of the coarse impurities. Several years ago 21 British fire clays, none of which would rank as grade 1 clay, were thus treated and 17 after such treatment would pass the tests for grade 1 so far as Al_2O_3 content was concerned. An exptl. apparatus for deflocculation and electrolytic collection is described. The ordinary treatment is to blunge 1 kg. of clay with 2 kg. H_2O to which has been added 2–3 cc. of a 10% solution of Na-silicate, NaOH or Na_2CO_3. Blunging takes $1^1/_2$ to 2 hrs., settling 1 to $1^1/_2$ hrs. to remove coarse impurities, settling of the suspended liquor 2 hrs. to allow finer impurities to settle out after which the suspended clay is ready to be collected. By using clays thus treated the use of a special "fusible bind clay" may be avoided. Increased plasticity, gotten by deflocculation and subsequent precipitation, makes use of a larger % grog possible. Grog should be of exactly the same compn. as the raw clay. Grog should be burned hard enough to avoid after-contraction. Black-cored grog should not be used for it causes blow-holes. Grinding should be done in an edge runner mill and a good body of material kept under the runners so the action will be crushing to angular fragments rather than grinding to spherical forms. The ground product should be run over an electromagnet. Sizing is of first importance. Mixing in an edge-runner machine is not satisfactory. Pugging also is inefficient. Slipping is the only way of getting a satisfactory mixture. H_2O with alkali added should be warm when put into the blunger; the clay should be added first, then the fine grog, lastly the coarse grog and blunging should take about 2 hrs. Slip-casting of pots has these advantages, (1) absence of joined surfaces, (2) larger and more grog may be used, (3) uniform H_2O content during drying (4) lower sintering temp. (5) quicker drying. A vacuum applied to the outside of the plaster mold overcomes many of the difficulties of casting and details are discussed. For casting covered pots the vacuum process seems indispensable. Pressure applied on the inside during forming may also be very advantageous. C. H. KERR.

Glass.

Glass making before and during the war. HARRY J. POWELL. *J. Roy. Soc. Arts*, **67**, 485–95 (1919).—Forty-four years ago de la Basties' process of toughening glass by quenching it in oil was discussed at a similar meeting. Glassmaking has been carried on in London for over 300 years. In 1696 there were 24 glass factories in the London district. London's preëminent position was later lost however. Before the European War the English glass industry was alive but not much more. Chance kept alive with difficulty the making of optical glass and some automatic bottle machines had been introduced in Yorkshire plants. There was very little scientific knowledge available and very little provision for its development. The war forced developments in both science and practice. At the Whitefriars plant was melted the special spectacle glasses for Sir William Crookes, other special

glasses, and thermometer tubing equal to the best German product. The author hoped to make thermometer tubing superior to the Jena 16 III and 59 III but the publication of formulas for the pre-war German glasses, which thermometer makers accepted as official standards, has interfered. The effect of free trade on the glass industry was disastrous and figures are given to prove it. After war was declared the making of vases and fancy table ware was stopped and the men and equipment were used for essential wares. A number of Na-Ca-Al glasses were introduced for mine-horns, for X-ray bulbs and for thermometers, also resistance glass in 4 colors for ampoules, enamels for thermometers, sealing flux for X-ray bulbs, blue enamel for cat's eye levels, white opal glass for arc-lamp shades, sheet glass containing oxide of didymium (for Sir William Crookes), sheet glass containing U (for the Admiralty), a neutral glass for acetylene welders, a dense black glass for airmen's goggles, anti-heat and anti-glare spectacle glass containing Ce, glasses and enamels for artificial eyes, dense lead glass for X-ray shields, etc. Efforts of the various concerns were concentrated on the following: Bagley & Co. Ltd., installing Owen's automatic bottle machines; Breffit & Co., jam and fruit bottles and food containers; Burtles, Tate & Co., Ltd., chemical and lighting ware; Edinborough & Leith Flint Glass Co., electric lighting bulbs for miners' lamps and trench and naval signalling, wireless telegraph valve glass, soft soda glass for lamp working and various colored glasses; Edison and Swan Glass Works, electric lamp bulbs, bulbs for half-watt lamps, for wireless telegraph valves, special colored glasses for signalling, a dark blue glass for ship lighting when running with lights out, and opal tubing; Frank Tomey & Co., soda glass tubing for laboratory ware, thermometer glass, etc.; Greener & Co., installing labor saving machinery for making tumblers, etc.; Molineaux Webb & Co., lighting, chemical and medical glass; Pilkington Bros., gas mask eye-pieces, photo plates, glass screens, searchlight projectors, tables for picric acid making, non-actinic glass for aerodrome roofs, blue glass for stern lights etc.; Stevens and Williams, table ware, chemical and medical glass, miners' lamps, electric bulbs and lighting ware; Stewart & Sons, electric light bulbs; Thos. Webb & Sons, lamp bulbs, glass tubing and rod, chemical ware and table glass; North British Glass Works, glass parts for aeroplanes, combustion glass, laboratory glassware, miners' safety lamps, etc., Duro Glass Works, a Na-K-Ca-Al glass for lamp-working and a Zn boro-silicate resistance glass for beakers and other laboratory ware; Wood Bros. Glass Co., electric light bulbs, laboratory and scientific glassware, flash-lamp lenses and X-ray bulbs, food containers; Derby Crown Glass Works, optical glass; Osram-Robertson Lamp Works, electric lamp bulbs; Chance Bros. & Co., optical glass, special colored glasses for sextants, plate glass for transmitting ultra-violet, a specially transparent blue filter, a uranium glass of great intensity of fluorescence, high pressure lamp globes, heat-resisting glass, glass for gas masks and Crooks' spectacle glass. In conclusion the author shows that very complete adoption of machine processes is essential to the future of the English glass industry. C. H. KERR.

The examination of optical glass in relation to weathering properties. ALFRED VINCENT ELSDEN, OSWALD ROBERTS AND HAROLD SPENCER JONES. *J. Soc. Glass Tech.*, **3**, 52–70 (1919).—On glass parts of optical munitions of war considerable trouble has been encountered in England due to a film or deposit on the glass surface. There seemed to be 2 kinds of films: (1) small, discreet globules easily visible under low power magnification and (2) extremely minute particles, forming a more or less uniform "bloom" but sometimes recognizable under high magnification as having a globular structure. The trouble was especially marked in hot climates. Some of these troubles were due to poor cleaning or to foreign substances getting onto the lenses but some was from the glass itself. Weathering properties depend primarily upon chem. compn. but the nature of the surface is also an important factor. Weathering resistance has been tested quite commonly by heating in an autoclave at temps. up to 180° C with water. The conditions, however, differ so widely from those of practice that results may be questionable for some types of glass at least. Surface solubility tests are not easily made on optical glass because of the form of the product. Powdered samples might be tested but the exposed surface area is uncertain and in optical glass it is very desirable to test the actual polished surface. Zschimmer's method (cf. *Z. Elektrochem.*, **11**, 629 (1905)) of comparing hygroscopicity by heating polished specimens at 80°C in air practically saturated with water vapor and comparing the resulting deposits seemed very promising. The iodoeosin test also deserved further study, the freshly broken surface being compared with a broken surface after seven days' weathering in moist air at 18°. The iodoeosin test gave concordant and valuable results, except when applied to the heavy and complex optical glasses. For the "dimming" tests a special thermostat and auxiliary apparatus was constructed to permit careful control in passing a stream of moist air over the specimens at 80°C. The apparatus is described in detail. Test specimens are preferably polished plates $1^1/_2'' \times {}^7/_8'' \times {}^1/_8''$, and "blanks" of quartz glass are run in every test alongside the glass sample or samples. No quantative measurement of the "dimming" effect seemed possible but classification was attempted with fair success by assigning a value of 1 to samples unaffected or only very lightly affected; 2 affected; 2 decidedly affected; 3 very seriously affected. The table shows the compn. of some optical glasses tested.

Mark.	Glass.	SiO_2.	B_2O_3.	CaO.	BaO.	PbO.	ZnO.	Sb_2O_3.	Al_2O_3.	MgO.	Na_2O.	K_2O.	SO_3.	H_2.	Reputation.
A	Ca-Na-K silicate	73.03	.....	6.91	.....	.....	....	....	0.74	0.53	12.24	4.38	1.35	....	Very poor
B	Ca-Na silicate	74.63	.....	6.95	.....	0.07	0.39	0.37	3.19	0.11	14.51	.....	....	....	Very poor
C	Ca-Na silicate	73.83	.....	7.08	.....	.....	....	....	1.73	0.15	16.59	0.21	....	....	Very poor
D	Ca-Na-K silicate	73.82	.....	7.16	.....	0.12	....	0.30	1.43	0.27	13.21	3.77	....	....	Very poor
E	Ca-Na-K silicate	71.31	.....	10.08	.....	.....	....	....	1.39	0.23	6.70	10.31	....	0.17	Fair
F	Ca-Na silicate	71.70	.....	11.41	.....	.....	....	0.33	1.92	0.29	13.64	0.99	....	....	Fair
G	Ba-Na silicate	67.02	.....	0.86	9.88	.....	2.01	....	0.70	0.35	17.35	1.40	....	....	Very poor
H	Pb-Na-K silicate	65.24	.....	0.57	.....	12.00	2.16	....	1.45	0.36	13.53	4.53	....	....	Very poor
I	Ba-Na-borosilicate	68.22	10.11	0.60	3.19	.....	....	....	1.33	0.32	13.34	2.89	....	....	Good
J	Pb-K silicate	43.09	.....	.....	.....	43.52	....	0.10	0.80	....	2.22	9.89	....	0.22	Doubtful
K	Ba-Pb-Zn-K silicate	56.65	.....	.....	14.75	10.28	4.01	....	0.38	....	2.04	11.93	....	....	Good

The following table shows the dimming test and iodoeosin results with the above and other glasses:

Glass.	Dimming test (30 hrs.) classification.	Freshly broken surface.	Broken surface weathered 7 days at 180° C.
A	3	0.30	2.21
B	3	0.39	0.60
C	3	0.39	0.37
D	2+	0.16	0.25
E	1+	0.13	0.11
F	1+	0.13	0.14
G	3	0.21	0.31
H	2+	0.66	0.97
I	1	0.02	0.04
J	2	0.35	0.36
K	1+	0.13	0.13
Plate	3	0.13	0.27
Hard crown	2	0.25	0.26
Spectacle crown	2+	0.29	0.26
Soft crown	3	0.14	0.51
Medium Ba crown	1	0.14	0.06
Ba silicate crown	2+	0.12	0.35
Ba silicate crown	2—	0.24	0.24
Ba silicate crown	2	0.09	0.06
Ba light flint	2+	0.17	0.59
Ba light flint	1+	0.11	0.12
Ba light flint	2	0.14	0.27
Light flint	1+	0.41	0.16
Light flint	2+	0.11	0.12
Heavy flint	2	0.35	0.36
Heavy flint	1	0.11	0.12
Heavy flint	2	0.43	0.11
Extra dense flint	1+	0.15	0.11

These tests are sufficient to show the great value of such a test as the dimming test. Further work will be done. Some expts. have indicated the possibility of carrying out the test satisfactorily at a lower temp. than 80°C or in a shorter time than 30 hrs. or both. C. H. KERR.

The annealing temperatures of the lime-soda glasses. S. ENGLISH AND W. E. S. TURNER. *J. Soc. Glass Tech.*, **3**, 125–8 (1919); cf. *Ibid.*, **2**, 90 (1918); *C. A.*, **12**, 2240.—Only the most general relationships between annealing temp. and compn. are as yet known. Practical experience has shown that lead glasses are readily annealed while chem. glassware requires a high anneal-

ing temp. and most careful cooling. The glasses now studied cover a wide range of soda-lime glasses including the more important com. glasses. The compns. follow:

Glass.	SiO_2.	Na_2O.	CaO.	MgO.	Al_2O_3.	Fe_2O_3.	As_2O_3.	Total.
1.....	74.05	25.34	0.21	Trace	0.24	0.14	..	99.98
2.....	73.92	23.80	1.50	Trace	0.20	0.14	..	99.56
3.....	74.08	23.00	2.61	Trace	0.21	0.15	..	100.05
4.....	74.07	21.50	3.81	Trace	0.28	0.14	..	99.80
5.....	73.78	20.78	4.50	0.15	0.38	0.19	..	99.78
6.....	73.18	19.38	6.26	0.21	0.58	0.61	..	100.22
7.....	74.41	17.20	7.45	0.24	0.30	0.40	..	100.00
8.....	74.99	16.00	8.16	0.26	0.31	0.09	..	99.81
9.....	74.96	14.88	9.36	0.28	0.42	0.16	..	100.08
10.....	74.59	14.22	10.38	0.30	0.45	0.21	...	100.15
11.....	74.93	13.02	11.68	0.31	0.38	0.17	..	100.49
16.....	66.71	12.72	18.17	0.85	1.41	0.31	0.30	100.47
17.....	69.73	11.22	17.38	0.55	0.50	0.25	0.47	100.10

The complete detn. of the annealing conditions for any glass involves detn. of (1) the upper annealing temp. at which annealing occurs most readily without deformation, (2) the lower annealing temp. below which the annealed glass can be cooled rapidly without strain and (3) the rate of cooling between (1) and (2). Only (1) is considered here. Strain was noted by optical examn. of short rods, 3 cm. long and 8 mm. diameter. The results are averages of 2 detns.

Glass No.	CaO.	Annealing temp. °C.	Glass No.	CaO.	Annealing temp. °C.
1.....	0.21	483	8	8.16	552
2.....	1.50	490	9	9.36	562
3.....	2.61	492	10	10.38	581
4.....	3.81	503	11	11.68	601
5.....	4.50	512	16	18.17	608
6.....	6.26	526	17	17.38	613

Calculating the compn. to empirical formulas and keeping $Na_2O = 1.0$, the annealing temp. varies with CaO equivalent as follows: 0.0 CaO, 480°C; 0.5 CaO, 510°C; 1.0 CaO, 560°C; 1.2 CaO, 590°C. Results show that glasses with high alkali can be annealed at a fairly low temp. and although requiring a higher temp. than lead glasses, they nevertheless resemble the latter in softening readily. With increase in lime the glass hardens and a higher

annealing temp. is required. The ordinary, white flint (lime-soda) glass used for medical bottles, paste, sauce, pomade bottles etc., has a compn. like Nos. 7 and 9. Other constituents if present in appreciable amts. will, of course, modify the required annealing treatment. C. H. KERR.

The exploitation of glass sand in the United States of America. P. G. H. BOSWELL. *J. Soc. Glass Tech.*, **3**, 72–8 (1919); cf. *C. A.*, **12**, 214.—At Ottawa, Ill., the St. Peter's Sandstone of Carboniferous age is worked. The best is used for glass plants. There is only 1–2 ft. of soil overburden. At the largest workings, those of the Ottawa Silica Co., the blasting shatters the soft rock and subsequent immersion in water causes complete disintegration so it is sluiced down and then handled by belt elevator with cross battens. The sand used for glass making has the following typical size of grain: over 1 m/m, 0.5%; 1.0–0.5 m/m, 21.6; 0.5–0.25 m/m, 75.6%; 0.25–0.10 m/m, 1.3%; 0.10 to 0.01 m/m, 0.3%; below 0.01 m/m, 0.7%. At Rockwood, Mich. a very pure sand has lately been worked and used largely for optical glass. The deposit is in the Sylvania Sandstone of Silurian age. The rock is soft and crushes easily. A typical sieve test, in the same size divisions as indicated above, shows the following percentages respectively: 0.0, 2.2, 79.5, 79.5, 18.0, 0.2, 0.1%.

	Ottawa (washed).	Ottawa (unwashed).	Rockwood (not washed).
SiO_2	99.48	98.47	98.00
Al_2O_3	0.16	0.75	0.13
Fe_2O_3	0.02	0.08	0.012
TiO_2	n. d.	0.05	Trace
CaO	0.11	0.21	0.70
MgO	0.05	0.08	0.41
Na_2O	None	None	None
K_2O	None	0.06	None
Ign. loss	0.13	0.47	0.89

C. H. KERR.

Some experiments with a gas-fired pot furnace. MORRIS W. TRAVERS. *J. Soc. Glass Tech.*, **3**, 70–2 (1919).—In order to make about 5 tons of resistance glass per week and to start producing as soon as possible, a furnace based on the well-known type of horizontal gas-fired retort setting was made, using covered pots 36″ x 38″. Producer gas entered the arched space under the siege in each arch and ascended into the arch through two 6″ x 9″ ports in front of the pot. Secondary air, not preheated, met the gas about 8″ below the top of the siege. Thus the gas was burned as near the front of the pot as possible and cracking of pots down the front was cured. C. H. KERR.

Technical education in the glass industry. By a MEMBER OF THE STAFF. *Pottery Gaz.*, No. 507, 956–958 (1919).—A few years ago a Department of Glass Technology was founded at the Sheffield University in which students are being received and a degree may be obtained in glass technology. A special building taking the form of a small works was constructed where it is possible to produce glass on a semi-commercial scale. In the basement there is a special room for storing glass pots at a constant temperature. Open and closed pots are used, the former being made by the Department, while the latter, ranging in size from 28 pounds to $1^1/_2$ cwt., are bought. Another room contains the meters which register the consumption of gas and electricity, and a number of powerful air compressors. Another room contains grinding and polishing machines and also a special machine for testing the resistance of bottles to internal strains. There is also a batch mixing room containing special bins for storing raw materials. An automatic screen which separates the dry material into three degrees of fineness (greater than 30-mesh, between 30- and 100-mesh, and through 100-mesh), is used. The furnaces are on the second floor, including a pot arch of the Richmond recuperative type, a 56-lb. whirling furnace and a number of small experimental furnaces varying in capacity from 6 to 14 lbs. On the third floor instructions are given in glass blowing where at the present time a large number of wounded soldiers and girls are receiving instructions. H. G. SCHURECHT.

Silica rock and sand for glass making. F. GELSTHARP. *Rock Products*, No. 22, 29 (Oct. 1919).—Sand for use in glass making is of three physical types. (1) Wind or water deposits composed of loose quartz grains. (2) Sandstone rock composed of a soft or hard cemented mass of coarse grains. (3) Quartz or silica rock. The chemical purity of the sand depends entirely on the kind or grade of glass required. The following are chemical and mechanical analyses of sands satisfactory for the ordinary pale green and better grades of glass:

	1.	2.	3.	4.	5.
SiO_2	99.695	99.580	99.500	99.300	98.53
Fe_2O_3	0.025	0.040	0.045	0.109	0.18
Al_2O_3	0.080	0.150	0.225	0.367	0.83
CaO	0.030	0.060	0.030	0.022	0.02
MgO	0.020	0.020	0.020	0.022	0.05
Ignition loss	0.150	0.150	0.180	0.180	0.39
16- to 30-mesh particles (1.13 to 0.50 mm.)	20.3	5.0	3.2	1.4	0.9
30- to 60-mesh particles (0.5 to 0.22 mm.)	62.6	38.2	78.0	52.3	64.6
60- to 120-mesh particles (0.22 to 0.11 mm.)	14.6	53.0	16.3	45.4	30.0
Particles through 120-mesh	2.3	3.8	0.5	0.9	4.5

Fe_2O_3 is the most injurious impurity on account of its strong, color producing ability. Metallic iron, which is equally as harmful, may be introduced by the grinding of silica or quartz rock and hard sandstone-rock. When high-grade glass is required the sand should be passed over a magnetic separator. Al_2O_3 should not be present in large amounts. It is generally present as clay which is high in Fe_2O_3. If properly crushed sandstone is well washed the Al_2O_3 present as clay will be removed. If analysis then shows much Al_2O_3 remaining, it is present in soluble or insoluble silicates, feldspars, or other compounds which may or may not be injurious. CaO and MgO are present in most glass sands in unobjectionable amounts. Some sands contain vegetable matter which must be washed out to make them fit for use in glass. Sand grains larger than 16-mesh or smaller than 120-mesh size are undesirable. The large grains are slow in melting and may leave strings or striae in the glass. Sandstone grains of this size may consist of small grains held together by a cement containing an objectional impurity. The fine grains which pass a 120-mesh screen are not objectionable if they are as pure as the aggregate, but these fine particles usually contain more impurities than the grains of between 16- and 120-mesh size. The most desirable glass sands are those which have the largest amount of grains of size between the 40- and the 80-mesh screens. Sand, all of which passes the 100-mesh screen, is not desirable. It is liable to be carried out with the gases evolved during melting. If mixing is not thorough or the melting not properly carried out, "white knots," composed of balls of fritted silica, are produced in the glass. Also such sand is too bulky, requiring too long a time of filling. The time of melting is decreased by use of finely ground limestone but increased by use of finely ground sand. Fine sand lowers the heat conductivity of the glass batch much more than does the fine limestone since there is much more sand than limestone in the batch. The fluxes attack find sand more readily than coarse sand but the beginning of the action is delayed by the lowering of the heat conductivity of the raw batch. But in the case of the finely ground limestone its effect in decreasing the heat conductivity is greatly overbalanced by the more active fluxing action, due to the greater surface of lime exposed to the sand. The following figures represent the maximum amounts of Fe_2O_3 allowable in sand to be used in making glass for the ware indicated:

Optical and spectacle glass	0.025%
Better grade of flint and soda-lime glasses for pressed and blown ware	0.050%
Plate glass and pale bottles	0.100%
Common dark bottles	0.500%

F. A. KIRKPATRICK.

Enamels.

The enameling of lava. J. DARCHIE. *Ceramique*, No. 375, 145–6 (1919).—The lava of Volvic has been utilized, after being enameled, for many purposes including laboratory tables, hospital tables, baths, monuments, decorative

purposes, etc. The lava is mined in blocks, sawed and trued to the required shape and the porous surface is filled with a special composition. The enamel is applied by dipping, spraying or with a brush and the ware is then fired in muffle kilns. H. G. SCHURECHT.

Cement and Lime.

Discussion—The causes of unsoundness in portland cement. G. A. RANKIN. *Concrete, Cement Mill Section*, **15**, 33 (1919).—Discussion of article by B. F. Erdahl (*J. Am. Ceram. Soc.*, **2**, 673) restates Mr. Erdahl's summary as follows: (1) CaO is not the cause of unsoundness. (2) $2CaO.SiO_2$ is the cause. (3) Underburning produces a so-called "dusting" clinker and unsound cement. (4) This dust is more or less a disintegration product of an unstable $2CaO.SiO_2$. These points are discussed by Rankin as follows: (1) Microscopical examination of finely ground cement has shown that a grain of cement, even so small that it will pass a 200-mesh sieve, may consist of a perfectly sound shell, free from cracks, and enclose one or more particles of free lime. Such particles may be evenly distributed throughout the cement, and will ultimately cause unsoundness. The hydration or absorption of water by the shell of the cement grain may require a long time, and if, as generally happens, the water does not penetrate to the lime before the set, the cement will be unsound. Such cement is either under-burned or over-burned. Unsound cements of this nature may, of course, at times be made sound by sufficiently fine grinding. Mr. Erdahl presents data to show that as much as 15% CaO may be mixed with a sound cement without causing unsoundness. But in these experiments, the CaO gradually hydrated during the gauging of the cement, was completely hydrated before the cement set, and hence did not cause unsoundness. (2) $2CaO.SiO_2$ does not change chemical composition on dusting. This phenomenon is due to a 10% volume expansion which accompanies a change from a high temperature crystalline form to a low temperature form. All properly burned portland cement contains 25 to 35% $2CaO.SiO_2$ in the particular form which dusts under certain conditions. Fe_2O_3, alkalies, etc., prevent dusting if the clinker is burned at a sufficiently high temperature. Such clinker does not dust or disintegrate when ground and mixed with water. If this were not so, no cement structure could be considered safe. $2CaO.SiO_2$ in the "dusted" form is a very inert material, which does not hydrate readily, nor undergo any changes which could produce unsoundness. It is as so much sand, provided the $2CaO.SiO_2$ has completely "dusted." All commercial cements contain at least a small amount of "dusted" $2CaO.SiO_2$ and evidently "dusting" is generally complete by the time the cement is ground and made into pats. If this were not true, all cements would be unsound. The discussion is continued by Mr. P. H. Bates as follows: The question of soundness is generally misunderstood. When water is added to continual cement the products of hydration produce both an expansive and a cohesive force. The former may predominate with resultant disintegration. In the great majority of cases, however, the latter

exists in the greater amount and the product has cementitious properties. Which will predominate at any time, after gauging, depends upon the amount of certain constituents at the time of gauging. If a cement contains $^1/_2$% of the constituent producing expansive force and a low % of slow hardening (not slow setting—setting and hardening must be carefully distinguished) constituent, then at the end of 24 hrs. this cement may be unsound according to the boiling test, while a cement having the same amount of the constituent producing the expansive force, but a larger percentage of quick hardening constituent, would be sound. Furthermore, the first cited cement at the end of 48 hrs. after gauging, may be sound according to the boiling test. The changing of a cement from unsound to sound by storage in bulk is due to an increase in the amount of the expansive constituent and a consequent increase in the % of the cohesive constituent. If immediately after such a change has taken place some of the cohesive constituents are modified and changed to quick setting (and in this case slow hardening) constituents, by the use of a few tenths of a per cent of Na_2CO_3, the cement will again be unsound. This is due to the fact that the relative amount of the constituent producing the expansive force in hydrating has been changed. The constituent which produces the expansive force is free CaO. The amount of this necessary to produce unsoundness will depend upon the amount of quick hardening constituents, which are $3CaO.SiO_2$ and to a lesser degree $2CaO.SiO_2$ (stable form). That the "dusting" clinker referred to by Erdahl was unsound was due to the lack of quick-hardening constituents and not to the "dust," except insofar as it reduced the amount of the stable $2CaO.SiO_2$, that form of the silicate which is alone capable of hardening. For the same reason, the non-dusting material was sound, notwithstanding the fact that it may have contained the same amount of free CaO or even more. The discussion is continued briefly by other writers who agree with Mr. Rankin and Mr. Bates. Mr. Erdahl replies that in a future article he will give further evidence to prove his points, that he will discredit the embedding theory and show that it is the $2CaO.SiO_2$ which does not dust before the pat is set that is dangerous. F. A. KIRKPATRICK.

Formation and properties of blast-furnace slag and portland cement. *Genie civil*, **73**, No. 26, 512–3 (1919).—*Blast-furnace slags:* All blast-furnace slags contain from 5 to 15% Al_2O_3. Within the range of the said limits one can observe the following facts as regards lime and silica: The differences in the conditions of operation of blast-furnaces fired with wood and those fired with coke manifest themselves by corresponding differences in the composition, fusibility, and fluidity of the slags found in the two cases. In the wood-worked furnaces, for an Al_2O_3 content of the slag between 12 and 15%, the SiO_2 percentage varying between 40 and 55%, one finds that the minimum temperature at which the slag has a water-like fluidity lies in the neighborhood of 1350°C, in the presence of 45% SiO_2, and further that the melting point changes very little between the before-indicated limits or values. In the coke-fired blast furnace, the elimination of sulphur in the ashes makes it

necessary to increase the proportion of the bases, especially of CaO, which is distributed between the SiO_2 and the S in an up to the present none too well-known manner. The S would seem to become eliminated so much better the richer the slag in CaO; on the other hand, however, the higher the CaO content of the slag, the lower its fluidity. Slags with high-CaO contents flow while forming isolated drops, similarly as fused lead, while slags rich in SiO_2 flow in elongated drops or sometimes thread fashion like glass. The temperature at which markedly calcareous slags (with 13.50 to 23% CaO) begin to show ready fluidity is not much higher (20° to 25°C in fact) than the temperature at which they begin to grow soft, whereas it is from 200° to 300° higher than the softening point of very silicious slags. An examination of the fluidity diagrams shows that in the presence of great quantities of SiO_2 in the slag, say up to 60% and over, as results from wood firing, the said value may vary within very wide limits, by 15% approximately, without either the fluidity of the slag or the working temperature varying in a marked degree. Wholly different are the conditions relative to coke firing. In the presence of a content of 34% SiO_2 ($CaO:SiO_2 = 1.5$), the working temperature must be 200° higher than the temperature of softening, if the fluidity shall be adequate. Raising the SiO_2 content to 37% ($CaO:SiO_2 = 1.35$) the fluidity is much more marked, but desulphurization is incomplete. If the SiO_2 percentage be reduced to 32, the working temperature of the blast furnace must be raised notably, and this means a greater consumption of fuel so much more as also the quantity of slag becomes greater. If the necessary quantity of heat were not furnished, the result would be that the slag becomes pasty and the desirable desulphurizing effect, caused by high CaO contents, would largely be lost. These conclusions agree with those found in actual practice, although blast-furnace slags contain MgO, oxides of manganese and iron, as well as CaS_2, besides the said system $CaO–Al_2O_3–SiO_2$.

Portland cement: Diacalcium silicate, $2CaO.SiO_2$, exists in three different forms or phases, *viz.*, the α phase melting around 2130°; it passes at 1420° into the β modification, and at 675° into the γ modification, with the transformation being reversible. The change from the beta into the gamma modification is associated with an increase in volume. The presence of the beta phase in portland cement is one of the causes underlying its destruction by pulverization. The properties of clinker of portland cement could be rather easily ascertained were it solely constituted by combinations made up of CaO, Al_2O_3, and SiO_2, and if the whole had really passed through a state of complete fusion whereby homogeneity of the mass would be insured. However, the trouble is that often merely sintering, in certain portions at any rate, and incomplete fusion occur; and, apart from the three components $3CaO.SiO_2$, $3CaO.Al_2O_3$, and $2CaO.SiO_2$, regarding the existance of which scientists are practically unanimous, one finds also in the clinker free or uncombined CaO and the compound $5CaO.3Al_2O_3$ which result from an incomplete combination of the constituents. At all events, we may say that good cements of the usual grade as maufactured industrially should contain at least 90%

of the three components above referred to, while the balance of 10% is ordinarily made up of MgO, iron oxides, alkalies, etc. According to Rankin the formation of clinker would occur as follows: First, carbonic acid gases are given off as originate from the calcination of carbonate of lime employed as the raw material to furnish the CaO. After that, the two compounds, $5CaO.3Al_2O_3$ and $2CaO.SiO_2$, are very rapidly formed one after the other, which at once fixing additional quantities of CaO, result in $3CaO.Al_2O_3$ and $3CaO.SiO_2$. These latter two compounds, contradistinct from the two before-mentioned, form very slowly. Their formation is accelerated if brought about inside a molten medium, a flux, which promotes contact-making between solid molecules. Such a flux is formed rather rapidly, namely, the eutectic $2CaO.SiO_2$-$5CaO.5Al_2O_3$-$3CaO.Al_2O_3$ which melts at 1335°C. If the temperature goes beyond this point the formation of the compound $3CaO.Al_2O_3$ is hastened, and then $3CaO.SiO_2$ forms in turn from CaO and $2CaO.SiO_2$. In practice, the reactions are there stopped because one invariably keeps below a temperature at which the entire mass would be in molten state. In brief, in a measure as the temperature is raised, one is dealing with, or there are present, the following combinations (Table 1):

TABLE 1.

	1000°.	1000°–1335°.	1335°–1450°.	1450°–1650°.	Clinker solidifier.
$CaCO_3$	CaO	CaO	CaO	CaO	$2CaO.SiO_2$
Al_2O_3	Al_2O_3	$5CaO.3Al_2O_3$	$3CaO.Al_2O_3$	$2CaO.SiO_2$	$3CaO.SiO_2$
		$2CaO.SiO_2$	$2CaO.SiO_2$	$3CaO.SiO_2$	$3CaO.Al_2O_3$
SiO_2	SiO_2	$3CaO.Al_2O_3$	$3CaO.SiO_2$	Eutectic	

In reality, on account of the presence of small quantities of oxide of iron, of magnesia, alkalies, etc., the temperature obtaining inside the furnace and the constitution are slightly different. In practice, according to the nature of the cement manufactured, the following results are obtained for a well heated and treated cement (Table 2).

If the cement has not been properly heated, a portion of the lime and the bisilicate of calcium which should have entered into a combination to form a trisilicate have not come to react with each other, with the consequence that bisilicate subsists, and its presence in the beta modification in the cement as has been shown, is causative of the cement's destruction by swelling and pulverization. The mechanism of hardening of set cement is not yet well understood, but the mechanism of the setting is known almost certainly. These are the phenomena that happen when pulverized cement is tempered with water. Pure trialuminate of calcium, $3CaO.Al_2O_3$, like pure trisilicate of calcium, $3CaO.SiO_2$, set rapidly and then harden very fast, but the aluminate sets appre-

TABLE 2.

Type.	Composition of raw materials.			Maximun heating.	Composition of clinker.
Chemically pure cement.....	CaO	68.2	100	1650°	$2CaO.SiO_2$ $3CaO.SiO_2$ $3CaO.Al_2O_3$
	Al_2O_3	8.2			
	SiO_2	23.6			
White cement.....	CaO	66.2	100	1525°	$2CaO.SiO_2$ $3CaO.SiO_2$ $3CaO.Al_2O_3$ CaO in small quantities
	Al_2O_3	6.4	97.6		
	SiO_2	25.0			
	MgO, Fe_2O_3, Na_2O. K_2O.....	.....	2.4		
Gray cement (ordinary grade)	CaO	63.2	100	1425°	$2CaO.SiO_2$ $3CaO.SiO_2$ $3CaO.Al_2O_3$ $CaO.3Al_2O_3$ in small quantities CaO and ferrite
	Al_2O_3	7.7	93.3		
	SiO_2	22.4			
	MgO, Fe_2O_3, Na_2O K_2O, SO_3.....	.....	6.7		

ciably quicker than the silicate. Both of them form, first, amorphous hydrates with water. The bisilicate of calcium, $2CaO.SiO_2$, on the contrary, reacts very slowly with water. Not only is setting slow, but also its hardening requires very much time. Then also the free lime fixes water and gives rise in its turn to a hydrate crystallizing at the same time as this occurs with the amorphous hydrate formed by trialuminate of calcium. It does not seem that the hydrates formed by the bisilicates and trisilicates of calcium crystallize. Hence, the setting is due above all to the hydration of the aluminate, the hardening above all due to the hydration of the aluminate which continues, and to that of the trisilicate. The trisilicate, as a consequence, is that constituent of the clinker which contributes most to the cementation, seeing that the bisilicate sets and hardens at too slow a rate and the aluminate too rapidly. Moreover, the latter is rather soluble in water and it never becomes very hard. Hence, a cement is so much superior in quality, the higher the quantity of trisilicate of calcium it encloses. Now, the temperature at which it forms from lime and silica lies in the neighborhood of 1700°, which is much higher than the temperature ordinarily reached in furnaces, whence there results the necessity of having recourse to a flux facilitating its formation. Now, it is especially aluminate of lime which plays the part of the flux in the last phases or stages of the heating. The investigation of CaO-Fe_2O_3 made by Rankin demonstrates that Fe_2O_3 is able to play this part better than Al_2O_3 and may replace it in part. By further following up the investigation of this system, one may perhaps succeed in finding bases which may permit of obtaining products of definite properties in the fabrication of ferro-concrete (Eisenportlandzement) in which the Germans have been specializing. C. TREISCHEL.

Setting of plaster. C. H. DESCH. *Trans. Ceram. Soc.* (*England*), **18**, Part 1 (1918).—LeChatelier has shown that gypsum, $CaSO_4.2H_2O$, passes, at about 128°C, into the hemihydrate, $2\ CaSO_4$. The bulk of ordinary plaster is hemihydrate which is more soluble than the hydrate. On mixing with H_2O a solution, saturated with respect to the hemihydrate and supersaturated with respect to the dihydrate, results. Crystallization of gypsum takes place spontaneously or around nuclei furnished by the plaster itself. The strength of set plaster is attributed to interlocking lath-shaped crystals. Volume changes in setting are attributed to crystals pushing each other apart during growth. Effect of overburning on setting of plaster is also discussed. The general discussion is interesting. C. TREISCHEL.

CERAMIC PATENTS.

G. E. MIDDLETON, *Abstractor.*

General.

Water-purifying material and process of making it. H. KRIEGSCHEIM. U. S. 1,312,552, Aug. 12, 1919. In softening water it is the practice to use base-exchanging material containing in combination SiO_2, Al_2O_3, alkalies and

water–zeolites. The water is passed through a bed of this material exchanging the lime and magnesia, to which it owes its hardness, for the sodium contained in the base-exchange material. After a sufficient degree of action is attained the material may be revived by treatment with NaCl. The revived silicate is then ready for re-use. It is necessary that these base-exchange materials be mechanically strong and able to resist the action of water, a property which they do not naturally possess. The inventor claims that they may be heated to as high as 550° C for not more than two hours without substantial or permanent loss of the water of constitution upon which their activity depends. He therefore incorporates them in finely divided condition with a small proportion of clay and subjects the product to the above heat treatment. A hard, rigid but active material results which may be formed into pellets. Decayed obsidian is instanced as an example of the base-exchange material.

Clay-binder and process of making it. H. L. KOHLER. U. S. 1,312,853, August 12, 1919. Non-plastic clays, notably flint clays, are treated by this process to increase their bonding power and plasticity and also to enable them to be fired without danger of cracking. These results are said to be attained by adding a basic salt of aluminium to, or forming it within the clay. The basic salt operates as a binder during tempering and molding and during firing is gradually converted to its oxide without losing its effectiveness as a binder. From $^1/_2\%$ to 5% of anhydrous $Al_2(SO_4)_3$ is thoroughly mixed with wet clay and allowed to remain at atmospheric temperature. The reaction represented by the following is said to take place: $3(Al_2O_3.2SiO_2)+2Al_2(SO_4)_3+xH_2O = 4Al_2SO_4(OH)_4+Al_2(SO_4)_2(OH)_2+6H_2SiO_3+xH_2O$. In the firing these basic sulphates are converted into oxides and a portion of the latter are converted into silicates either by the silicic acid set free in the above reaction or by said acid and any free silica which may be present in the clay. At red heat the SO_3 radical is driven off and Al_2O_3 remains, a portion of which reacts with the silicic acid or free silica as follows: $Al_2O_3+H_2SiO_3+SiO_2=Al_2O_3.2SiO_2+H_2O$. The use of $Al_2(SO_4)_3$ is not imperative. Any mineral acid or salt capable of setting free the silicic acid of the aluminium silicate of the clay may be used. H_2SO_4, $(NH_4)_2SO_4$ and even $Zr(SO_4)_2$ are mentioned. Other argillaceous materials such as bauxite may be similarly treated and with similar results.

Means for supporting ceramic ware while being fired. H. J. RUSHTON. U. S. 1,313,018, Aug. 12, 1919. Several types of supports are disclosed, all being of open structure and designed for use in muffle kilns. One type comprises a rectangular base and end walls, the base being provided on its lower side at one end with a central foot or lug and at the other with a pair of laterally arranged feet or lugs designed to coöperate with members on the top of the end walls of a companion member, the whole arrangement to permit of sliding due to expansion of the parts when the supports are fired in superposed relation.

Tile-cutting machine. C. A. THORPE. U. S. 1,313,213, Aug. 12, 1919. The movement of the extruded hollow-tile bar governs the movement of the cutting table carrier. The carrier follows a curved path adjustable to correspond to any curvature which it may be desired that the tile possess. Automatic means are provided for cutting the tile radially.

Brick-mold. H. W. B. GRAHAM. U. S. 1,314,057, Aug. 26, 1919. A multiple brick mold designed for use in the Graham soft-mud brick machine. The mold is provided at its ends with supporting members extending laterally beyond the bottom boards and provided with upper and lower wide flat-bearing surfaces. These supporting members are adapted to engage with various parts of the brick machine as the mold moves through it.

Paving-brick. W. J. MCCLAIN, JR. U. S. 1,314,278, Aug. 26, 1919. This paving brick is designed to be laid flat instead of edgewise. It is provided with lugs on its lateral edges for interlocking with lugs on other bricks, these lugs being so located that they not only serve to space the brick from those bricks lying laterally thereto and interlocked therewith, and at the same time provide intermediate lateral spaces for the reception of joint-filling material, but they also serve to space the brick endwise from adjacent bricks.

Kiln. H. FRANCART. U. S. 1,314,486, Aug. 26, 1919. Checker-work furnaces extending from the crown to the floor are longitudinally disposed along the sides of this kiln, and communicate with the kiln chamber at their top and bottom. Air and gas are introduced from beneath the bottom of each furnace. The exhaust flue is located near the floor at one end. The inventor states that the products of combustion rise in each furnace, enter the kiln chamber at the crown, impart their heat to the ware and are drawn into the next furnace toward the exhaust flue at the floor level, thus pursuing a helicoidal path. This together with the heat stored in the checker work makes for uniformity of temperature.

Article adapted to be used as a light-reflector. H. FORD. U. S. 1,313,806, Aug 19, 1919. Pieces of alabaster or gypsum are imbedded in Keene's, Parian or Martin's cement. These cements are translucent and so the mixture is adapted to be made in shades or light-reflectors.

Mold for ceramic products. F. S. LOWRY. U. S. 1,314,821, Sept. 2, 1919. This mold is designed to provide offset handle-receiving projections on ordinary jiggered cooking utensils. Formerly these projecting ears have been formed by appropriate depressions in the mold wall adjacent to its upper periphery, but this resulted in making the ears flush with the upper edge of the utensil. In order to lower them the inventor provides the mold with removable inserts which fit over the ear molds.

Clay-pin drying and cutting machine. D. D. IRWIN. U. S. 1,315,507, Sept. 9, 1919. So-called clay-pins used to space articles of pottery apart during firing are dried and cut into appropriate lengths by this machine.

Pallet boards containing strips of die-expressed pin material are passed upon an endless conveyor through a steam-heated drier. After the clay has dried to approximately a leather-hard condition the strips are passed under a gang of rotary disc cutters and cut to length. The cut pins then proceed through the remaining length of the drier and are discharged in condition for firing.

Brick-veneering machine. J. ELDRIDGE. U. S. 1,315,916, Sept. 9, 1919. Brick are automatically fed to a conveyor and carried beneath coating mechanism to receive a coating of slip or glaze. After coating the brick are wiped at the corners leaving them square. More than one face of the brick may be coated.

Abrasives.

Abrasive material and method of making it. N. C. HARRISON. U. S. 1,314,061, Aug. 26, 1919. Diaspore is calcined and thoroughly mixed with previously ground coke and iron. Waste iron, such as cast iron borings, is suitable. The mixture is then fused in an electric furnace and allowed to cool and crystallize slowly. The finished product is said to be a compact, fine-grained mass, free from pores, making an excellent abrasive material, harder and tougher than corundum. The proportions of ingredients used to make a finished ton of abrasive are: diaspore, 3400 lbs., iron borings, 400 lbs., and coke, 600 lbs.

Manufacture of artificial abrasives. A. T. SNODGRASS. U. S. 1,314,835, Sept. 2, 1919. "Flour" emery, the finely powdered waste product from emery and glass-grinding mills, is used as the basis for this abrasive. To this is added another waste product, "flour" glass, the fine residue obtained from grinding cullet in the manufacture of glass paper. The proportions are 2 to 3 parts of emery to 1 part of glass. The two are intimately mixed and subjected to a temperature of not less than 1700°C. The resultant molten mass is poured on to a cool surface or otherwise allowed to solidify. When crushed and graded it is said to be suitable as a raw material in the manufacture of abrasive cloth, paper, and grinding wheels.

Apparatus for the fusion of refractory materials. R. A. HOYLE. U. S. 1,314,871, Sept. 2, 1919. This apparatus is especially designed for the fusion of bauxite in the manufacture of artificial abrasives, the inventor seeking to simplify the complicated furnace installations now employed for that purpose. A series of pits are arranged in rows on the mill floors, each constituting the crucible of an electric furnace. The electrodes are suspended from a traveler moving on overhead trackways so arranged that they may be lowered into any pit of the series. A hood adapted to cover a pit is similarly suspended. In operation the electrodes are lowered in the first pit, the hood fixed in place and the bauxite gradually fed in. As the ore melts the electrodes are raised. The material adjacent to the walls of the pits is not subjected to the extreme heat, is not fused and serves as a protection for these walls. When fusion is complete the electrodes are shifted to the adjacent pit. The cooled melts

are withdrawn by means of chains laid along the sides and bottom of the pit before introduction of the charge.

Glazes and Enamels.

Process of making opaquing- and enameling-compounds and the product. F. PREUSSER. U. S. 1,314,831, Sept. 2, 1919. The object of this invention is to reduce the quantity of the expensive opacifying oxides such as those of tin, zirconium and antimony used in glazes and enamels and at the same time effect the same degree of opaqueness. An opacifier meeting these requirements is said to be obtained by the mutual decomposition and reaction of two groups of enameling substances, one of these being the turbidity producing or opaquing-salts and compounds of the alkaline earth metals and some earth metals, the oxides of which do not possess this quality, while the other group consists of the opaquing oxides or compounds of the so-called border elements, that is those mostly tetravalent and partly trivalent comparatively, easily fusible, metallic elements which partake of the characteristics of metals as well as metalloids, such for instance as tin, titanium, zirconium, thorium, antimony and to some extent bismuth, arsenic and cerium. These two groups must be chemically combined. This combination may be effected in either the dry or the wet way. Phosphates, silicates and aluminates of the latter-mentioned metals which form opaquing oxides and chemical combinations thereof with the alkali earth metals are thus produced in which, owing to the mutual decomposition which has taken place, the clouding oxides such as SiO_2 are contained in an exceedingly fine, almost colloidal distribution, similar to a dyeing agent, so that this artificial product and the opaquing and enameling results thereby produced are entirely different from the natural silicates of the rare earth metals and the very weak clouding effects produced by them.

Several examples are given. One follows: Proceeding in the wet way, $ZrOCl_2$ 55 parts, $MgSO_4$ 2.5 parts, and $K_2Al_2(SO_4)_4.24H_2O$ (potash alum) 5 parts, are dissolved in water and treated with a solution of Na_3PO_4 20 parts, Na_4SiO_4 5 parts and NaOH 10 parts. A complex body containing silicates and phosphates of zirconium and aluminium with some phosphate and silicate of magnesium is formed. The soluble and volatile decomposition products are washed out. Proceeding in the dry way $Zr(OH)_2$, Al_2O_3 or $Al(OH)_3$ and $Ca_3(PO_4)_2$ are mixed and melted, and, if necessary, a small amount of $MgCO_3$ or $Na_2B_4O_7$ may be added to assist in the decomposition of the phosphate as well as for the purpose of regulating the melting of the mass and the adhering quality of the enamel.

The inventor states that these compounds may be used alone as glazes or in combination with ordinary fritted glazes as opacifiers.

Clouding-composition for enamels and process of making it. P. EYER. U. S. 1,314,861, Sept. 2, 1919. ZrO_2 and other zirconium compounds have

been substituted for SnO_2 as opacifiers but they produce spotted and dull or tarnished enamels. Zirconium borate is comparatively free from these defects but its covering capacity is insignificant. The inventor has found that zirconium borate strongly supersaturated with zirconium oxide, such for instance as a product of the composition $ZrO_2.2B_2O_3 + 4ZrO_2$, has a greater covering power than ordinary zirconium borate and at the same time does not cause spotting or dullness. The covering power of the compound is also increased by melting cryolite with it. Cheap, raw zirconia can be used provided an oxidizing agent is employed. Example: Raw ZrO_2 70 parts, B_2O_3 30 parts, Na_3AlF_6 20 parts, $NaNO_3$ 50 parts, are thoroughly mixed, fused and ground very fine.

Refractories.

Method of manufacturing magnesite refractories. R. D. PIKE. U. S. 1,312,871, Aug. 12, 1919. California magnesite runs higher in MgO than the Austrian, but the physical properties of bricks made from the latter, calcined, are much superior. Austrian magnesite bricks, fired to cone 18, are hard, dense and strong while those made from the California material are soft and have little strength. If the physical properties of the American product could be improved it would be a superior basic refractory because of its high MgO content. The inventor adds to this magnesite from 0.32% to 0.75% of powdered ferro manganese and from 1.5% to 2.5% of ferric oxide in the form of powdered iron ore or mill scale as low in impurities as possible. The whole is ground in a wet pan, molded into blocks and fired to cone 18. The iron oxide and ferro manganese react as follows: $8Fe_2O_3 + FeMn_4 + heat = 16FeO + Fe + 4MnO4$. The ferrous and metallic iron are active fluxes or bonding agents. A hard, dense, strong magnesite refractory containing high percentages of MgO is said to result.

Glass.

Manufacture of glass. H. A. GALT. U. S. 1,312,784, Aug. 12, 1919. Niter cake, a by-product in the manufacture of HNO_3 from $NaNO_3$, and cylinder cake, a by-product in the manufacture of HCl from NaCl, consist of a relatively large proportion of $NaHSO_4$ with a relatively smaller proportion of Na_2SO_4. It has been considered impractical to use them as ingredients of a glass batch because of their deliquescence and acidity, resulting in the formation of "salt water" which lies on the surface of the molten batch, attacks the container, interferes with the melting and handling and produces a scum on the glass. These objectionable features are obviated by grinding the niter or cylinder cake with a neutralizing base and adding it to the batch. As examples of this neutralizing base, Na_2CO_3 (soda ash), $NaHCO_3$, $CaCO_3$ (limestone) and $Ca(OH)_2$ are given. The following is a typical batch formula:

Sand	1000
Soda ash	298
Mixture:	
Soda ash 16 Niter cake 50	66
Salt (NaCl)	25
Limestone	309
Coal	3
Arsenic (As_2O_3)	5

Apparatus for feeding and delivering glass. J. SCHIES. U. S. 1,312,876, Aug. 12, 1919. A series of molds upon a rotary mold-table are successively passed beneath the glass feed. As each mold receives the required quantity of molten glass the flowing glass stream is automatically severed and deflected.

Lens-forming process. A. PELLOW. U. S. 1,312,920, Aug. 12, 1919. In forming a fused bi-focal lense a spherical countersink is formed in the major blank and a segment having a contrageneric toric surface is placed in contact with it. One of the curves of the segment is less and the other greater than that of the countersink. The two parts are then subjected to heat which softens this segment and causes it to roll out and assume the curvature of the countersink, forcing out all air bubbles in advance of contact between the parts.

Apparatus for rolling ribbed glass. W. COX. U. S. 1,313,071, Aug. 12, 1919. The cold spot and consequent peacock-feather appearance of ribbed glass are obviated by the use of a rolling table having shallow wide-angled grooves with flat-faced ribs between them cut in the surface of the table, about 20 grooves to the inch. The angle of the flat sides of the ribs between the grooves is from 5° to 40° to the plane of the table.

Glass-blowing apparatus. H. E. and C. L. QUACKENBUSH. U. S. 1,313,205, Aug. 12, 1919. This machine is especially adapted for blowing incandescent lamp bulbs. A glass tube is rotated without being subjected to a torsional strain so that when the glass is molten at an intermediate point in its length it will be sustained at such point without torque. Thus the tube can be successively treated at points along its length and converted into a series of bulbs arranged end to end.

Apparatus for annealing glass. J. W. CRUIKSHANK. U. S. 1,313,222, Aug. 12, 1919. Difficulty is experienced in cooling sheets of glass sufficiently during annealing so that when they are removed from the cool end of the lehr they will not crack upon contact with the cold air, especially in winter. Lengthening the lehr is impracticable. The inventor cools by convection, allowing access of air to the sheets at the lower end by increasing the size of the lehr runway or cooling chamber to the full size of the building containing

it. A general circulation of air is thus attained and the air is cooled by contact with the walls and ceiling of the surrounding building.

Apparatus for building up objects of quartz glass. W. S. QUIMBY and F. W. ROBINSON. U. S. 1,314,212, Aug. 26, 1919. Heretofore articles of quartz glass have been produced by merely drawing out a block of quartz glass heated to a plastic condition. This is expensive and involves much skill. The inventors build up objects by applying quartz powder to a heated nucleus of quartz glass and reheating to fuse the accretion. If the object to be made is a tube, the initial nucleus is made tubular and held in shape during the operation by compressed air within it. The nucleus tube is rotated by two supporting chucks and heated to plasticity by a gas burner. The burner is removed and a plate covered with quartz powder is moved beneath and in contact with the tube. The powder adheres and is then made to fuse onto the tube upon reheating with the burner. At the same time the work is elongated by drawing its ends apart sufficient to compensate for the added bulk of powder. This operation is then repeated until the desired length is reached.

Apparatus for making glass cylinders. G. C. DEBAY. U. S. 1,314,638, Sept. 2, 1919. A hydraulically operated apparatus for drawing glass cylinders. The cylinders are drawn through rings placed on the surface of the molten glass. When a cylinder has been drawn its full length these rings are raised whereupon the heat of the furnace melts the glass at the lower end and disconnects the cylinder from the glass in the tank. Hot air is admitted to the cylinders during drawing. The apparatus is designed to draw two cylinders simultaneously.

Mechanism for delivering glass. R. NETTER. U. S., 1314,691, Sept. 2, 1919. Molten glass is fed to molds situated on a continuously rotating mold table. An auxiliary spout follows each mold through a predetermined arc of its travel; the flow of glass is then automatically shut off and the spout returned to contact with the mold next succeeding.

Mechanism for effecting spindle movements in glass-forming apparatus. A. KADOW. U. S. 1,315,130, Sept. 2, 1919. This machine is particularly designed for the manufacture of electric-light bulbs or other hollow-glass articles. The blank is developed on a spindle or blow-pipe by blowing, by swinging the blank out through oscillating movements of the spindle and by revolving the spindle on its longitudinal axis with the blank inclosed in the mold. In order to fix or set the blank in the holding jaws of the spindle and center the air employed in blowing, the spindle is provided with a plunger which is thrust into the inner end of the blank immediately after the blank has been received from the gathering mechanism. Improved mechanism is provided for operating the plunger without sidethrust. Improved means are also provided for accurately centering the spindle.

Charging apparatus for glass-molds. R. T. MCGEE. U. S. 1,315,562, Sept. 9, 1919. Glass is fed to a press mold without being exposed to the air

or the chilling which results from the use of a relatively cold ladle or other gathering instrument. The glass flows horizontally from the bottom of the tank to the bottom of a vertical well at the top of which the mold is seated. Extending laterally from the bottom of the well and in direct communication with the horizontal duct is another horizontal passageway leading to an adjacent vertical, cylindrical, auxiliary tank at the top of which is a water-cooled, loosely fitting plunger. All of the ducts mentioned and the lower part of the auxiliary tank are surrounded by highly heated fire spaces to prevent chilling of the glass therein. The glass rises in the well because of the pressure in the tank and is forced into the bottom of the awaiting mold by depressing of the plunger in the auxiliary tank. As the mold is filled it is slid transversely, shearing the glass column and making way for a succeeding mold. In a modified form the glass flows out at the top of the well and drops into an open-topped mold.

Method of feeding glass. G. E. HOWARD. U. S. 1,315,668, Sept. 9, 1919. The diameter of a stream of molten glass flowing through an orifice may be varied by varying the pressure which is forcing the glass therethrough. This is due to the fact that the adherence to the edge of the orifice is greater than the internal friction of the molten glass. Thus it is possible by varying the flow to expand or contract the section of the stream near the orifice and make it assume a predetermined form within narrow limits. Advantage is taken of this fact in forming gobs of desired size for discharge to a mold.

The glass flowing down through the orifice first assumes the more or less globular shape 6 shown in Fig. 1. At the same time that this initial flow takes place, a certain amount of glass may be drawn up into the tube 3, then as the flow continues out through the orifice 2 and when the globule 6 elongates,

FIG. 1

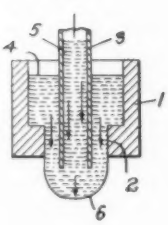


FIG. 2

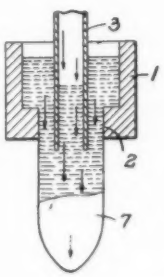


FIG. 3

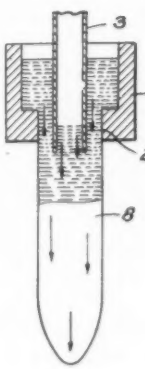
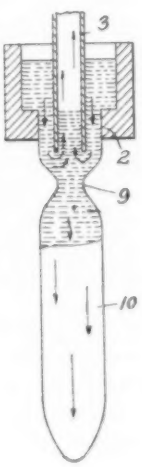


FIG. 4



and thereby tends to become attenuated or thin, the glass in the tube 3 may be forced out as shown in Fig. 2 to fill in the center of the globule and cause the globule to assume substantially the form shown at 7, Fig. 2. Continued expulsion of the glass from the pipe 3, as illustrated in Fig. 3, causes the globule to maintain substantially a uniform diameter, as shown at 8, Fig. 3, so that there then is a mass of glass ready for discharge into a mold, or the like, which is of substantially uniform diameter and practically predetermined shape, and mass.

When now it is desired to cut off this globule to leave the same in the mold, the sucking action into the tube 3 may be resumed, as shown in Fig. 4, and may be made sufficiently rapid to cause a decided contraction in the globule at the point 9. It will be understood, however, that the flow of the glass down between the orifice 2 and the walls of the pipe 3 has not thus been checked, but after the glass has passed into and partially out of the orifice it is drawn up into the tube 3 instead of being supplied to the completed globule 10. The glass globule is then cut off at the point 9 in the ordinary manner.

Method and apparatus for manufacturing incandescent-lamp bulbs. R. LE ROSSIGNOL. U. S. 1,315,783, Sept. 9, 1919. A tubulator through which an incandescent-lamp bulb may be exhausted is formed in the wall of the stem or flare and not in the bulb itself by locally heating the desired spot on the stem and inserting a mandrel in the thus softened glass.

Bulb-cutting machine. R. W. SUMAN. U. S. 1,315,799, Sept. 9, 1919. A machine for automatically feeding and cutting the necks of miniature lamp-bulbs blown from glass tubing.

Method of manufacturing incandescent lamps. M. H. BRANIN. U. S. 1,315,813, Sept. 9, 1919. Incandescent-lamp bulbs are blown with elongated unrestricted necks terminating in a heavy ring of glass. The filament support may be readily inserted in such a neck without first trimming it as has heretofore been necessary with bulbs having necks with restricted ends. The final sealing may be effected as usual.

Cement.

Manufacture of potash and cement. A. C. SPENCER. U. S. 1,312,592, Aug. 12, 1919. Cement is made using potash-bearing minerals such as orthoclase feldspar, glauconite, nephelite, mica etc., and the potash recovered in water-soluble form. The process is characterized by two clinkering operations and the use of either an excess or a deficiency of lime in the first clinkering. The clinker obtained by the first operation is pulverized preferably by the use of water. The potash removed in the two clinkering operat ons is collected from the dust and the gases of the kiln in any suitable way. The inventor claims a higher yield of potash by this method than by those described in U. S. 1,209,135 and 1,209,219.

Rotary-kiln. J. S. FASTING. U. S. 1,313,281, Aug. 19, 1919. The feeding-end of this rotary cement kiln is provided with a series of helically arranged

chains secured to the inner wall of the kiln with the inner end of each chain in advance of the outer end circumferentially and in the direction of rotation of the kiln. As the kiln rotates the chains lift the slurry, exposing it to the action of the furnace gases and at the same time, because of their helical arrangement, cause it to pass toward the discharge end of the kiln.

Process of making porous concrete. E. WALTER. U. S. 1,313,931, Aug. 26, 1919. Small pellets of paraffin are mixed with cement mortar. When the resulting concrete has set the paraffin is removed by melting it or by extracting it with solvents such as gasoline, benzine or carbon tetrachloride. A porous concrete is said to result.

Rotary kiln. P. A. BOECK. U. S. 1,314,461, Aug. 26, 1919. In the lower temperature zones of this rotary cement-kiln a layer of kieselguhr bricks is interposed between the refractory lining of the kiln and the outer shell. The kieselguhr tends to prevent heat losses and the result is a higher temperature in the lower temperature zones.

Burned shale and method of preparing it, and concrete made therefrom. O. OLSEN. U. S. 1,314,752, Sept. 2, 1919. Shale rock is fired in a kiln at a temperature of 2000° F or above, for a period determined by the nature of the rock, so that it is reduced to a light, porous, hard material. It is stated that this product is useful in the refining of sugar or oil but the inventor discusses its use primarily as an aggregate for concrete. The following concrete mixture is given: coarsely crushed, burned shale 4 parts, finely crushed burned shale 2 parts, portland cement plus 10% magnesia cement 1 part. Concrete made according to this formula is said to weigh from 80 to 84 pounds per cubic foot, to resist a temperature of 3800° F without injury and to possess great tensile and compressive strength. It is especially adapted for marine work, barges, ships and railroad ties.

Composite building material. E. VIENS. U. S. 1,314,772, Sept. 2, 1919. The material has the following composition: Portland cement 30–65%, asbestos or other non-combustible fiber 10–55%, hydrated lime 2–10%, silicious material 2 to 15%, sawdust or equivalent 2 to 10%. It is said to be fireproof and resilient and above all possesses the property of taking nails, tacks or screws even better than wood.

Process and apparatus for cooling cement-kiln gases and the recovery of dust therefrom. L. STEVENS. U. S. 1,315,254, Sept. 9, 1919. Cement-kiln gases carrying suspended matter are mingled with a regulated amount of water-saturated air immediately upon their exit from the kiln and then further mingled with a current of cool air. The gases thus cooled are passed through a dust separator and the suspended matter precipitated in a physically dry condition.

Plaster composition. L. V. ECKERT. U. S. 1,315,597, Sept. 9, 1919. A plaster composition composed of cement plaster and straw meal in substantially equal proportions.

Note.— Copies of these patents may be obtained for ten cents each by addressing the "Commissioner of Patents, Washington, D. C."

AMERICAN CERAMIC SOCIETY.

Acquisition of New Members during October, 1919.

Resident Associate.

Bachman, P. S., 92 W. Maynard Ave., Columbus, Ohio.
Brown, Byron P., Vice-president and Gen. Mgr., Hercules Porcelain Co., Belvidere, Ill.
Charron, Roy C., Supt. and Chemist, Crunden Martin Mfg. Co., St. Louis, Mo.
Chu, Kea Hin, International General Electric Co., Harrison, N. J.
Flint, Francis C., Chief Chemist, Hazel-Atlas Glass Co., Washington, Pa.
Hollmayer, John G., Sec'y and Treas., K. B. H. American China Co., 5210 Norwood Park Ave., Chicago, Ill.
Jones, Chester H., Industrial Editor "Chemical and Metallurgical Engineering," 1570 Old Colony Bldg., Chicago, Ill.
Kahn, Isaac, Owner, Wheatley Pottery Co., 2428 Reading Rd., Cincinnati, Ohio.
Kenyon, S. Spicer, Alfred University, Alfred, N. Y.
Krebs, A. E., Belleville Enameling Works, So. 16th St., Belleville, Ill.
Ling, S. C., International General Electric Co., Harrison, N. J.
Panchot, L. D., 2nd Asst. Supt., Pittsburgh Plate Glass Co., Ford City, Pa.
Proodian, E. K., Chemist and Asst. Supt., Florentine Pottery Co., Cambridge, Ohio.
Rahn, Robert C., Ceramic Engineer, Western Electric Co., 4642 West End Ave., Chicago, Ill.
Reid, William H., Alfred University, Alfred, N. Y.
Sheppard, Mark, Fellow in Refractories, Mellon Institute, Pittsburgh, Pa.
Sherwood, Robert F., Ceramic Assistant, Bureau of Standards, Pittsburgh, Pa.
Smyser, Albert E., Engineer of Refractories, 239 South Fairmont St., E. E., Pittsburgh, Pa.
Talbert, E. Hume, Patent Lawyer, 711 Eighth St., N. W., Washington, D. C.
Wilkins, Wm. W., 2608 Leland Ave., Chicago, Ill.

Foreign Associate.

Catecliff, John, Chemist, Lodge Sparking Plug Co., Ltd., Rugby, England.

ACTIVITIES OF THE SOCIETY.

Actions of the Board of Trustees:

Nov. 24th. President R. T. Stull appointed Mr. H. F. Staley as delegate from the American Ceramic Society to the Industrial Safety Codes Conference, at the Bureau of Standards, Washington, December 8, 1919.

Nov. 26th. It was voted to sanction the purchase of an adding machine for the Secretary's office.

Nov. 26th. It was voted that all copies of the Index to the Transactions be bound in uniform manner with the bound volumes of the Transactions.

Nov. 26th. It was voted to send the Journal of the Society to the Association de Documentation Bibliographique, Scientifique, Industrielle, et Commerciale, of Paris, France, in return for a place, with critical notice, for the Journal in an Index which the Association is to publish.

Nov. 26th. It was voted to elevate Professor O. J. Whittemore, of Iowa State College, Ames, Iowa, to active membership.

LOCAL SECTIONS.

Northern Ohio Section.

HOTEL CLEVELAND, CLEVELAND, OHIO.

DEC. 1, 1919.

The following program will be afforded:

1.30 P.M. CERAMIC SYMPOSIUM:

1. "Testing Fire Bricks," by Dr. A. F. Gorton, Ceramist, Buckeye Clay Pot Co., Toledo, Ohio.
2. General discussion on refractories.
3. General discussion on fuels.
4. General discussion on ceramic problems.

Business Session. Report of Secreatry-Treasurer for 1919. Installation of Officers.

B. A. RICE,
Secretary.

New York State Section.

ALFRED UNIVERSITY, ALFRED, N. Y.

DECEMBER 15 TO 17, 1919.

A short course in ceramics will be held in connection with this meeting. The object of the short course is to give managers,

superintendents, foremen and workmen in ceramic plants an opportunity to gather in a few days a general understanding of the technology of the industry in which they are interested. Ample opportunity will be given for discussion of any subject which may be raised so that any one having problems which are giving trouble will be greatly benefited by attending the course. The program follows:

MONDAY, 1.30 P.M.

Lecture: "Developments and Prospects in Ceramics," by C. F. Binns, Alfred University, Alfred, N. Y.

Laboratory demonstration of deflocculation and elutriation, by C. F. Binns.

Laboratory demonstration by J. B. Shaw and G. A. Bole, Alfred University, Alfred, N. Y. Califoric value of coal; Fusion point of ash; Specific heat of ceramic products.

8.00 P.M.

Reception by the Faculty at the home of Professor and Mrs. Binns.

TUESDAY, 9.00 A.M.

Lecture: "The Burning Process," by A. V. Bleininger, Bureau of Standards, Pittsburgh, Pa.

Laboratory demonstration by J. B. Shaw and G. A. Bole: Heat balance of a kiln; Burning behavior of a clay.

1.30 P.M.

Lecture: "Porcelain," by A. V. Bleininger.

Laboratory demonstration by J. B. Shaw and G. A. Bole: Slag test of fire brick; Spalling test.

Calibration of electric pyrometers, by W. A. Titsworth, Alfred University, Alfred, N. Y.

8.00 P.M.

Studio demonstration: Making and decoration of pottery, by Elsie Binns and Marion Fosdick, Alfred University, Alfred, N. Y.

Reception by Department of Applied Art.

WEDNESDAY, 9.00 A.M.

"The Proctor Dryer," by D. H. Applegate, Philadelphia Textile Machinery Co., Philadelphia, Pa.

"The Tunnel Kiln," by P. Dressler, American Dressler Tunnel Kiln Co., New York City, N. Y.

1.00 P.M.

"Refractories for the Glass Industry" by A. V. Bleininger.

"Special Refractories," by S. C. Linbarger, Carborundum Co., Niagara Falls, N. Y.

"Electrical Porcelain," by L. E. Barringer, General Electric Co., Schenectady, N. Y.

J. B. SHAW,
Secretary.

Eastern Section.

RUTGERS COLLEGE, NEW BRUNSWICK, N. J.
DEC. 18, 1919.

The winter meeting of the New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society will be held as usual at Rutgers College, New Brunswick, N. J. The following program will be afforded:

MORNING SESSION: 10.30 A.M.

Address: By Charles Howell Cook, Chairman.

"Properties of Some Pottery Bodies and Glazes," by H. G. Schurecht, Bureau of Mines, Columbus, Ohio.

"Feldspar as a Pottery Material," by H. F. Staley, Bureau of Standards, Washington, D. C.

LUNCHEON: 1.00 P.M.

AFTERNOON SESSION: 2.00 P.M.

"The New Jersey Museum of Ceramic Products," by Helen C. Perry, State Museum, Trenton, N. J.

"Fuel Analyses," by A. C. Fieldner, Bureau of Mines, Pittsburgh, Pa.

"The Use of Fuel Oil in the Firing of Ceramic Kilns," by R. L. Clare, Federal Terra Cotta Co., Woodbridge, N. J.

"A Producer-gas Fire Box," by R. H. Minton, General Ceramics Co., Metuchen, N. J.

G. H. BROWN,
Secretary.

INDUSTRIAL DIVISIONS.

The following letter has recently been forwarded to all officers of the Industrial Divisions of the Society.

DEAR SIRS:

The membership work has been decidedly neglected the last month or so by the Membership Committee as a body, although each one has been doing

some individual work. The bulk of the work which has been done in securing new members has been by the Divisions and if they function as they should the Society may look to them to secure a great many members with whom no one else would come in contact. Particularly commendable work has been done by the Glass Division, the Terra Cotta Division, the Refractories Division, and the Enamel Division. Some of the Divisions have shown no activities whatever and it is hoped that they will arrange programs in somewhat similar manner to the other Divisions so that they may have their share of prominence in the Society.

As you know, the Board of Trustees voted that ten per cent of the dues and fees, as of 1919, of members who have, or shall have, become members of an Industrial Division, shall be allotted to that Division for legitimate expenses such as circulars, letters, postage, stenographic expenses, etc. This should not only assist in the work of your Division but will mean that each new member you secure will strengthen your particular Division, not only in numbers, but also financially. It is hoped that all of your members will work with this fact in view as we feel sure it will greatly assist in increasing the membership of the Society as a whole.

One of the greatest things the Divisions can do to keep alive the enthusiasm of the members would be to arrange a publication committee or in some other way have your Division coöperate with the Editor and Publication Committee so that an article of interest to your Division would appear in each issue of the JOURNAL.

You will note in the September issue that the Glass Division not only has an article on glass but also has notes of interest to the Glass Division. Also note that this Division has arranged for and appointed a Central Committee, not only to create enthusiasm, but also to answer questions concerning everyday glass practice. Undertakings of this sort cannot help but increase the strength of their Division.

The Terra Cotta Division has outlined eleven lines of research upon which work is being done throughout the country. They will, no doubt, present papers on these subjects at the coming meeting and will also have one of these papers published in each of the issues of the JOURNAL, meaning, of course, that something of interest to the Terra Cotta Division will be in each JOURNAL.

It is earnestly hoped that all of the Divisions will create as much enthusiasm among their members as the two Divisions just mentioned. The Membership Committee will do all it can to assist in this work and will greatly appreciate any suggestions or advice.

It would be helpful to the Membership Committee if the secretary of each Division keep the writer posted as to the Division activities.

Yours very truly,

F. H. RIDDLE,

Chairman, Membership Committee.

AMERICAN CERAMIC SOCIETY.

Annual Meeting.

The annual meeting of the Society will be held at the Bellevue-Stratford Hotel, Philadelphia, Pa., February 23 to 26, 1920.

At the call of President Stull, eighteen members met in Philadelphia on the evening of Wednesday, November 5th, to make plans for the meeting. A strong local committee was organized, of which Mr. Frederic Stanger was elected chairman. The committee has held several meetings since the above date and sub-committees on hotel reservations, reception and divisional meetings have been formed.

At this convention meetings will be held in sections for the first time. The Terra Cotta, Refractories, Glass and Enamel Divisions have already requested separate rooms for the reading and discussion of papers. It is planned to have a general meeting on Monday, February 23rd, and Divisional sessions on Tuesday, February 24th.

Members of the Society are urged to make hotel reservations at once for the week of the meeting.

Further details in reference to the meeting may be secured by writing to Mr. Frederic Stanger, Enterprise White Clay Company, Philadelphia, Pa.

Those wishing to contribute papers to the program of this meeting should communicate with Mr. R. H. Minton, Chairman, Committee on Papers and Programs, General Ceramics Co., Metuchen, N. J.

1920—Summer Meeting.

The following notice has been issued by the English Ceramic Society:

"The American Ceramic Society has sent a cordial invitation to our Society to visit the States in 1920. A special executive committee has been appointed by our American friends to arrange works' visits, etc. This invitation has given great pleasure to our

members and our Society has appointed Mr. Arthur Heath the Honorary Organizing Secretary on this side.

It is anticipated that the excursion will occupy a little less than a month. Arrangements will probably be made for joint discussions on subjects of special interest.

Please make all communications respecting the excursion to Mr. Arthur Heath, Central School of Science and Technology, Stoke-on-Trent."

It is planned to hold the Summer Meeting of the American Ceramic Society at the time of the visit of the English Ceramic Society, so that joint sessions of the two Societies may be held. A definite time for holding the meeting has not been decided upon, although it will probably be some time during the month of September.

The Glass Division of the American Ceramic Society has invited the English Society of Glass Technology to hold a joint meeting during the latter part of the summer of 1920. It is hoped that these dates may be made to coincide with those of the visit of the English Ceramic Society. The time tentatively set for the visit of the Society of Glass Technology is the early part of September, as during August glass plants are usually shut down because of the excessive heat at that time. An additional reason for postponing the meeting until September is that the Exposition of Chemical Industries will be held in New York during the week of September 20th. An opportunity to visit the Exposition will be an added inducement for our English friends to visit this country.

Definite plans are now being formulated for the itinerary and entertainment of our English friends during their visit to this side. These will be announced at an early date.

ERRATUM.

J. Am. Ceram. Soc., **2**, 807, Oct. 1919. In Table 1, left hand column, the positions of Whiting and Feldspar should be reversed.

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¶ Actual records were kept for 365 days of the burning of 9-inch, high-grade, refractory brick in one continuous tunnel kiln and in seven 30-foot round kilns, during which time 5,110,000 brick were burned in the tunnel kiln as against 5,040,000 in the seven round kilns.

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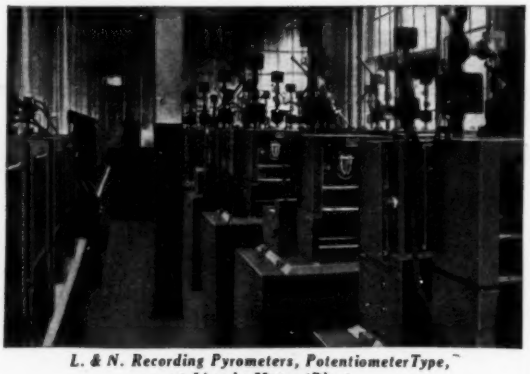

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May	6 1912	4
Nov.	20 1912	12
Feb.	11 1914	1
Apr.	13 1915	3
July	17 1916	1
Dec.	7 1916	1
Mar.	31 1917	1
May	19 1917	4
June	23 1917	1
Oct.	26 1917	3
Nov.	1 1917	4
June	29 1918	9

Beth. Steel Co.

June	16 1913	1
Oct.	15 1913	1
Nov.	1 1913	1
May	8 1914	1
May	14 1914	3
May	6 1915	1
Dec.	14 1915	2
Nov.	7 1916	3
Jan.	4 1917	1

Beth. Steel Co.

May	14 1917	1
Aug.	14 1917	1
Dec.	3 1917	52
May	24 1918	1
July	15 1918	2
April	9 1918	2
May	21 1918	2
July	20 1918	1
Jan.	22 1918	5
Sept.	10 1918	1
Oct.	4 1918	1

Halcomb Steel Co.

Mar.	13 1916	1
Oct.	27 1916	1
Oct.	29 1918	2
Dec.	27 1918	1

Watertown Arsn'l

Sept.	23 1912	1
June	30 1914	1
July	1 1914	1
Mar.	24 1916	1
May	8 1917	1

Watertown Arsn'l

June	4 1917	1
June	25 1917	1
Oct.	15 1917	5
Oct.	23 1917	18
Oct.	27 1917	6
Jan.	5 1918	1
Dec.	2 1918	1

Packard Motor Car Co.

July	9 1908	4
May	13 1914	1
June	14 1914	1
June	26 1915	1
June	28 1915	7
Aug.	16 1915	1
Feb.	25 1916	4
Feb.	3 1917	1
Dec.	1 1917	2
Jan.	11 1917	14
Mar.	9 1917	1
Dec.	16 1918	4
April	22 1919	4

DuPont Co.

Aug.	23 1915	5
Oct.	15 1915	2
Oct.	27 1916	1
Oct.	28 1916	1
Oct.	29 1916	1
Jan.	5 1916	1
Jan.	8 1916	2
Jan.	8 1917	1
Mar.	25 1917	1
July	24 1917	1
July	26 1917	2
Nov.	11 1917	1
Feb.	19 1918	1
Mar.	28 1918	1
Oct.	12 1918	1
April	4 1919	1

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May	11 1916	1
June	26 1916	10
April	1 1917	1
May	7 1917	5

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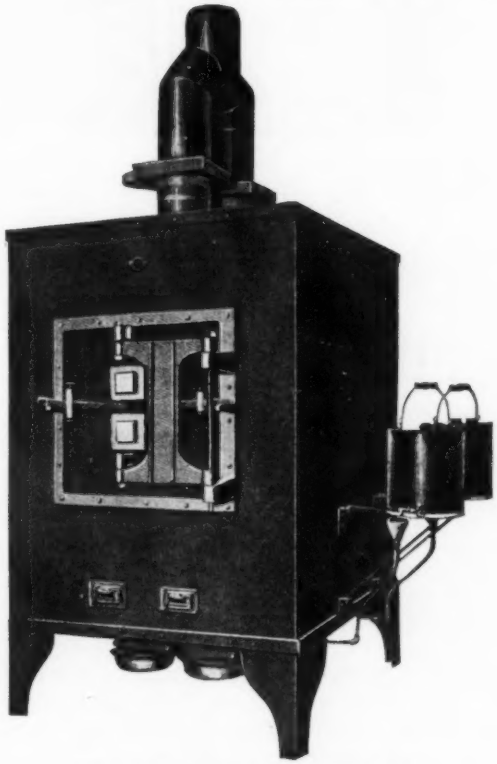

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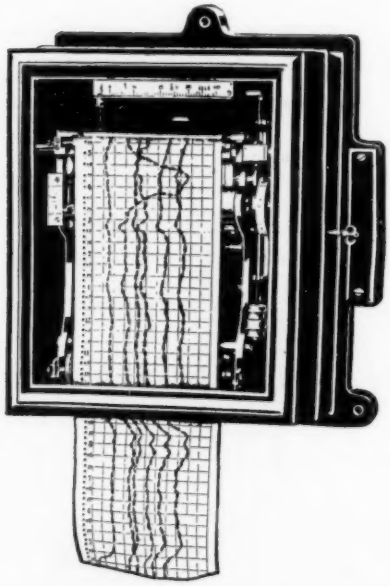

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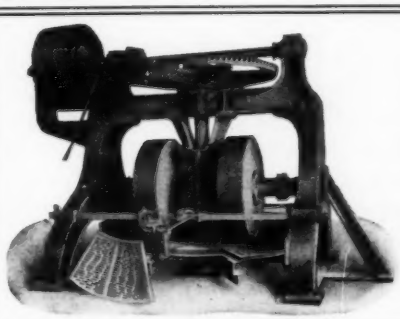

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402	Plain Green	402
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404	Olive Green	404
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701	Ivory Mother of Pearl	701
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703	Pearly Blue	703
704	Pearly Green	704
705	Pearl Grey	705
706	Light Pearl Grey	706
707	Pearly White	707
800	White	800
900	Green Blue Bronze	900
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